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IS 15870 (2009): Road Vehicles - Use of Compressed Natural Gas (CNG) Fuel System In Internal Combustion Engine Vehicles - Code of Practice [TED 26: Automotive vehicles on NCES]

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सड़क वाहन — भीतरी दहन इंजिन वाहनों में संपीडित प्राकृतिक गैस (सीएनजी) ईंधन प्रणाली के प्रयोग — रीति संहिता

Indian Standard

ROAD VEHICLES — USE OF COMPRESSED NATURAL GAS (CNG) FUEL SYSTEM IN INTERNAL COMBUSTION ENGINE VEHICLES — CODE OF PRACTICE

ICS 43.060.040

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

May 2009 **Price Group 12**

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Automotive Vehicles Running on Non-conventional Energy Sources Sectional Committee had been approved by the Transport Engineering Division Council.

In the formulation of this standard considerable assistance has been derived from the following standards, issued by Automotive Research Association of India:

AIS-024 (Amd 4 to version 3) — Safety and procedural requirements for type approval of CNG operated vehicles

AIS-028 (Version 3) — Code of practice for use of CNG fuel in internal combustion engine vehicles

Till the time there is an Indian Standard on Analysis of Automotive Rubbers by Fourier Transform Infra-red Spectrometry (FTIR) and Thermogravimetry (TGA) Techniques, method prescribed in AIS-066 may be followed for identification of EPDM rubber (*see* Note under Table 2).

Following documents may be referred for latest update on statutory requirements related to use of CNG fuel system in Internal Combustion Engine Vehicles:

Central Motor Vehicle Rules, 1989 (CMVR) (As amended from time-to-time)

Motor Vehicle Act, 1988 (MVA) (As amended from time-to-time)

Gas Cylinder Rules, 2004 (As amended from time-to-time)

The composition of the Committee responsible for the formulation of this standard is given in Annex F.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

ROAD VEHICLES — USE OF COMPRESSED NATURAL GAS (CNG) FUEL SYSTEM IN INTERNAL COMBUSTION ENGINE VEHICLES — CODE OF PRACTICE

1 SCOPE

1.1 This standard covers general safety and installation requirements and methods of test for checking the functionality of CNG onboard fuel system intended for use on motor vehicles defined in IS14272 (Part 1), two wheelers, construction equipment vehicles (CEV). It also provides general layout guidelines for CNG operated vehicles and guidelines for instructions.

1.1.1 This standard is applicable to vehicles using compressed natural gas (mono-fuel, bi-fuel applications). It is not applicable to the following:

a) Liquefied natural gas (LNG) fuel system components located upstream of, and including, the vaporizer;
b) Fuel containers;
c) Stationary gas engines; and
d) CNG fuel systems for the propulsion of marine craft.

NOTE — It is not intended to cover the areas where major structural modifications are to be carried out to the vehicle (major structural modifications are those not defined in **4.13**). Prior to commencement of such work, guidance should be sought from the vehicle manufacturer.

1.2 This standard is based upon a service pressure for compressed natural gas as a fuel at 20 MPa settled at 15°C. Other service pressures could be accommodated by adjusting the pressure by the appropriate factor (ratio). For example, a 25 MPa service pressure system will require pressures to be multiplied by 1.25. All references to pressure are to be considered gauge pressures unless otherwise specified.

NOTE — The fitment of a CNG fuel system shall be prohibited in any vehicle with a passenger compartment heating system, which draws air from the engine compartment unless the heating system is made inoperable and gas-tight to the passenger compartment.

2 REFERENCES

The following standards contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
1364	Hexagon head bolts, screws and nuts of product grades A and B:
(Part 1) : 2002	Hexagon head bolts (Size range M1.6 to M 64) (*fourth revision*)
(Part 3) : 2002	Hexagon nuts, style 1 (Size range M1.6 to M 64) (*fourth revision*)
2171 : 1999	Specification for portable fire extinguishers, dry powder (cartridge type) (*fourth revision*)
3224 : 2002	Valve fittings for compressed gas cylinders excluding liquefied petroleum gas (LPG) cylinders — Specification (*third revision*)
14272 (Part 1) : 1995	Automotive vehicles — Types — Terminology: Part 1 Three and four wheelers
15710 : 2006	Road Vehicles — Compressed natural gas (CNG) fuel system components — General requirements and definitions
15712 : 2006	Road vehicles — Compressed natural gas (CNG) fuel system components — Automatic valve (solenoid valve)
15713 : 2006	Road vehicles — Compressed natural gas (CNG) fuel system components — Pressure regulator
15714 : 2006	Road vehicles — Compressed natural gas (CNG) fuel system components — Gas/Air mixer
15715 : 2008	Road vehicles — Compressed natural gas (CNG) fuel system components — Conduit (ventilation hose) (IS *under preparation*)
15716 : 2006	Road vehicles — Compressed natural gas (CNG) fuel system components — CNG high pressure fuel line (rigid) with end connections [having pressure exceeding 2.15 MPa (21.5 bar)]

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IS No.	*Title*
15717 : 2006	Road vehicles — Compressed natural gas (CNG) fuel system components — Petrol valve (automatic/manual)
15718 : 2006	Road vehicles — Compressed natural gas (CNG) fuel system components — CNG high pressure fuel line (flexible hose) with end connections (having service pressure exceeding 2.15 MPa)
15719 : 2006	Road vehicles — Compressed natural gas (CNG) fuel system components — Electrical wiring kit
15720 : 2008	Road vehicles — Compressed natural gas (CNG) fuel system components — Compartments/Sub-compartments
15721 : 2006	Road vehicles — Compressed natural gas (CNG) — Fire retardant material for seat, upholstery, roof and side lining
15722 : 2006	Road vehicles — Compressed natural gas (CNG) fuel system components — CNG low pressure flexible fuel line with end connections [CNG fuel line having pressure not exceeding 2.15 MPa (21.5 bar)]
15723 : 2006	Road vehicles — Compressed natural gas (CNG) fuel system components — Current limiting devices

3 TERMS AND DEFINITIONS

For the purpose of this standard, the definitions given in IS 15710 and the following shall apply

3.1 Notified Body — Government appointed body mandated to approve or disapprove (for example: laboratories, universities and companies).

3.2 Authorized Person — A person, normally an automotive workshop person, authorised by the vehicle manufacturer or the conversion kit manufacturer/kit supplier specially trained for installation, maintenance and periodic inspection of motor vehicle converted for bi-fuel or dedicated operation of internal combustion engined vehicles.

3.3 Heavy Motor Vehicle — A vehicle for either goods or passenger services as defined under the *Central Motor Vehicle Rules* (CMVR) as applicable.

3.4 OE Fitment — A vehicle which is manufactured for CNG operation by the vehicle manufacturer prior to their first registration.

4 SAFETY REQUIREMENTS

4.1 General Design Requirements

4.1.1 The CNG on-board fuel system components as shown in Fig. 1 and Fig. 2 shall comply with this standard and the relevant component standard. Equipment and systems approved by the relevant Statutory Authority/Test Agency shall be used.

4.1.2 The high-pressure system as defined in **1.2** shall be designed on the basis of the service pressure.

4.1.3 For bi-fuel vehicles, provision shall be made to avoid accelerated deterioration of the non-CNG fuel system as a result of sustained operation on natural gas. Such measures shall be as recommended by the original vehicle manufacturer (for example, fuel hoses).

4.1.4 All fuel system components shall fulfil the following conditions:

a) They shall withstand the environmental temperatures and other environmental conditions safely during their operational life.

b) They shall be located with full guard for anticipated damage while the vehicle is being used safely. Such damage may be caused by the vehicle itself, by extraneous factors such as heat, road debris, automotive chemical splash (brake liquid, oil, petrol, cooling liquid, etc) or by rust.

c) They shall be fitted so that they are not the outermost, highest or lowest parts of the vehicles; otherwise they shall be protected.

d) They shall be fitted so as not to affect ground clearance, approach angle, ramp (break-over) angle and departure angle as defined by the vehicle manufacturer.

e) They shall be located so that they will not suffer corrosion damage by accumulation of water or cargo chemicals.

4.1.5 Gas cylinder valve shall be located with suitable protection in an accessible and safe place.

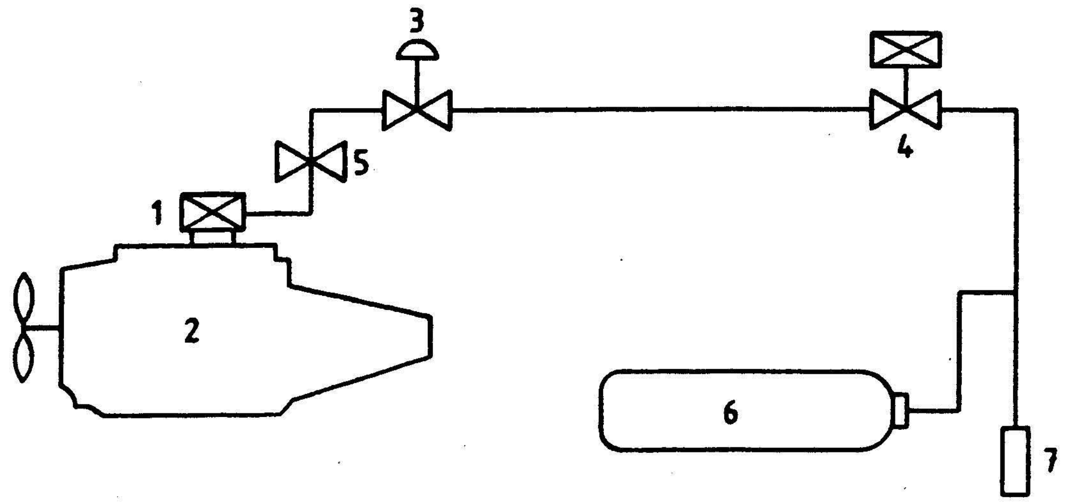
4.1.6 The CNG on-board fuel system shall include:

a) An automatic shut-off valve, and

b) A manual or manual override valve located on each gas cylinder.

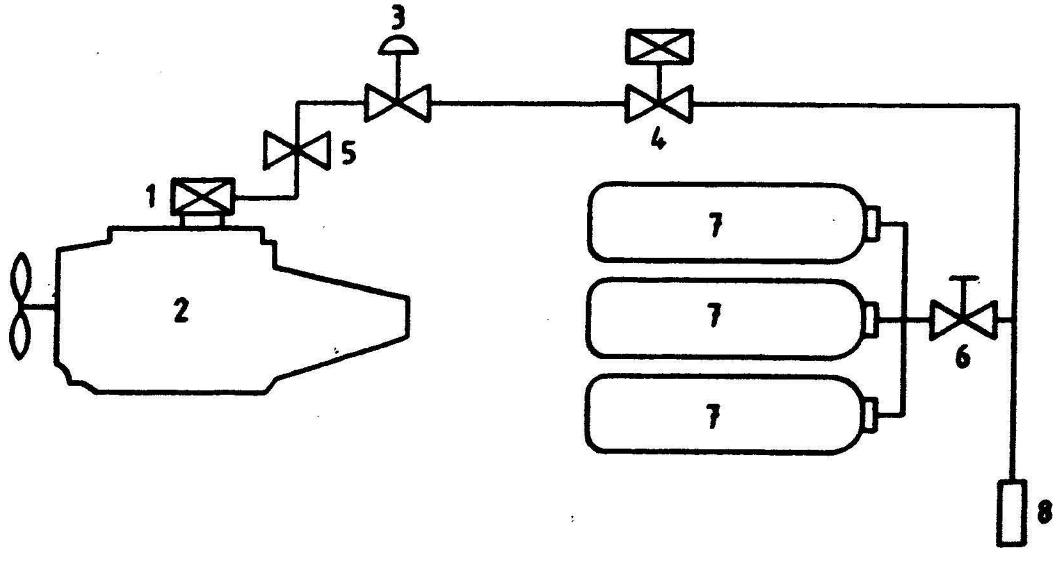
4.1.7 The CNG on-board fuel system may include a device (excess flow valve) inside the gas cylinder or a functionally equivalent system to control gas leakage in the event of a rupture in the fuel supply system.

4.1.8 The automatic shut off valve shall be in closed position when engine is not running and only be open when:



1. Gas/air mixer (or gas injector system)
2. Engine
3. Pressure regulator
4. Automatic shut-off valve
5. PRV (Safety device to prevent over pressure)
6. Gas cylinder + cylinder valve + PRD
7. Refilling receptacle

FIG. 1 SINGLE CYLINDER SYSTEM



1. Gas/air mixer (or gas injection system)
2. Engine
3. Pressure regulator
4. Automatic shut-off valve
5. PRV (Safety device to prevent over pressure)
6. Manual shut-off valve
7. Gas cylinder + cylinder valve + PRD
8. Refilling receptacle

FIG. 2 MULTIPLE CYLINDER SYSTEM

a) CNG operation has been selected, either manually or automatically, and
b) The engine is cranking or running.

4.2 Cylinder

4.2.1 *Design Approval*

Cylinders shall be approved/endorsed by the Department of Explosives as per *Gas Cylinder Rules*, 2004 (as amended from time-to-time).

4.2.2 The weight of the CNG cylinder(s) will affect the unladen weight of the vehicle and therefore consideration of the effect on the legal and manufacturer's rating and axle loadings should be considered.

4.2.3 In no circumstances shall the vehicle's critical load distribution affecting safety considerations be compromised.

4.2.4 Cylinders shall be re-tested as per *Gas Cylinder Rules*, 2004 (as amended from time-to-time).

4.3 Fittings on Cylinders and Filling Connection

4.3.1 *Cylinder Valve*

Each cylinder shall have a manual cylinder shut off valve mounted directly on it capable of shutting off all gas flow from that cylinder. Cylinders and shut-off valve assemblies shall be approved/endorsed by the Department of Explosives, as per IS 3224 and *Gas Cylinder Rules*, 2004 (as amended from time-to-time).

4.3.2 *Filling Connection*

The filling connection shall be of the NZS/NGV-1 or any other type as specified by the Government of India from time-to-time.

The basic dimensions for NZS type are as given in Fig. 3 and recommended sizes of NGV-1 type of filling connection are SAE 9/16" and 7/8". However, the vehicle manufacturer/kit installer may seek the guidance from The Gas Authority of India Ltd/Ministry of Petroleum and Natural Gas about the use of specific type of NGV-1 nozzle.

4.3.3 The NZS type filling connection shall be provided with a captive dust plug and NGV-1 type filling connection shall be provided with dust protection cap.

4.3.4 *Position of Filling Connection*

The filling connection shall be located in suitably protected and ventilated location, usually the engine compartment, and shall comply with the following:

a) The filling connection is made and filling is supervised from outside the vehicle. The filling connection may be made only if the method of access to it from outside does not result in the opening of a vapour path to the interior of the vehicle, thereby negating the effectiveness of a compartment or sub-compartment.
b) The filling connection is protected by being located in a recess below the surface of a body panel, or by being located so that equivalent protection is provided by the construction of the vehicle.
c) The filling connection shall be attached to motor vehicle in such a manner as to resist, without permanent deformation of the mounting attachment, a proof load of 50 kgf applied in the forward and reverse directions of travel of the vehicle.

   The proof load shall be applied by full engagement of the filling connection and shall be representative of attempted movement of the vehicle while refueling.
d) The filling operation can be carried out without requiring the operator to lie or crawl under the vehicle or be otherwise subjected to inconvenience, discomfort or hazard.
e) Minimum receptacle clearance (for NGV-1): The minimum receptacle clearance is shown in Fig. 4.
f) Recommended position and orientation of filling receptacle for 3-wheeler (ref schematic for '*X*', '*Y*' and '*Z*' in Fig. 4)
   1) '*X*' dimension shall be 70 ± 10 mm, which is measured in horizontal plane from the internal edge of window provided for filling beneath the passenger seat
   2) '*Y*' dimension shall be 50 ± 10 mm, which is measured in vertical plane from the internal edge of window provided for filling beneath the passenger seat.
   3) '*Z*' dimension shall be 70 ± 10 mm, which is measured in horizontal plane from the internal edge of window provided for filling beneath the passenger seat.
   4) Orientation angle with respect to horizontal plane shall be 25° to 30° (as shown in the following schematic).
   5) Free space around the receptacle shall be minimum 40 mm radius.

4.3.5 *Refuelling Interlock Device*

Filling connections in motor vehicles shall be fitted with a system that prevents the engine starting when the dust plug or dust protection cap is removed. This system shall isolate the starting device of the vehicle.

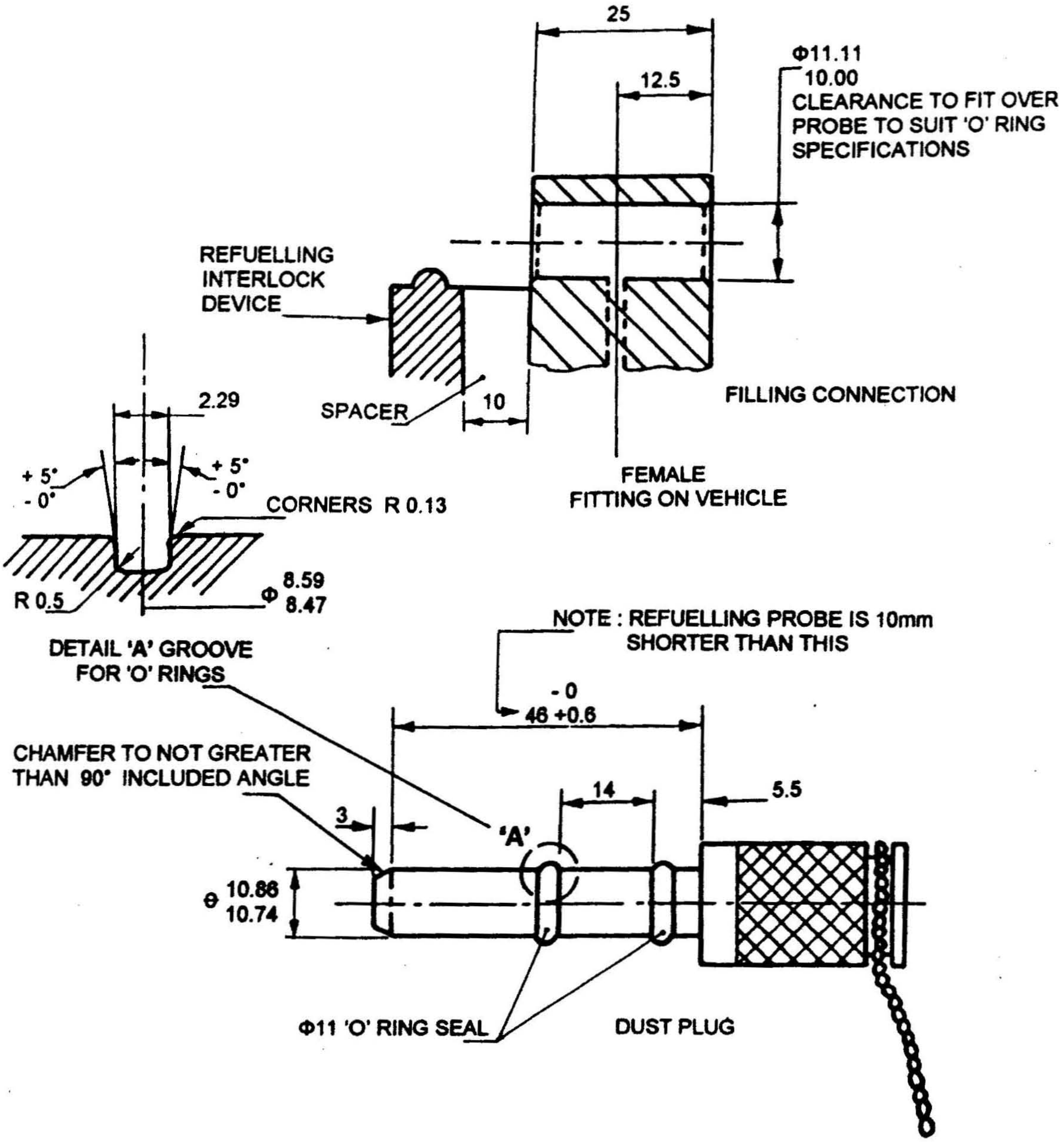

25
12.5
Φ11.11
10.00
CLEARANCE TO FIT OVER PROBE TO SUIT 'O' RING SPECIFICATIONS
REFUELLING INTERLOCK DEVICE
SPACER
10
FILLING CONNECTION
FEMALE FITTING ON VEHICLE
2.29
+ 5°
- 0°
+ 5°
- 0°
CORNERS R 0.13
R 0.5
Φ 8.59
8.47
DETAIL 'A' GROOVE FOR 'O' RINGS
NOTE : REFUELLING PROBE IS 10mm SHORTER THAN THIS
- 0
46 +0.6
CHAMFER TO NOT GREATER THAN 90° INCLUDED ANGLE
3
14
5.5
'A'
θ 10.86
10.74
Φ11 'O' RING SEAL
DUST PLUG

FIG. 3 FILLING CONNECTION AND DUST

4.3.6 *Non-return Valve*

There shall be a non-return valve fitted on the refueling line to prevent the return flow of gas from the cylinder to the filling connection. The non-return valve shall be located as close to the filling connection as it is practicable.

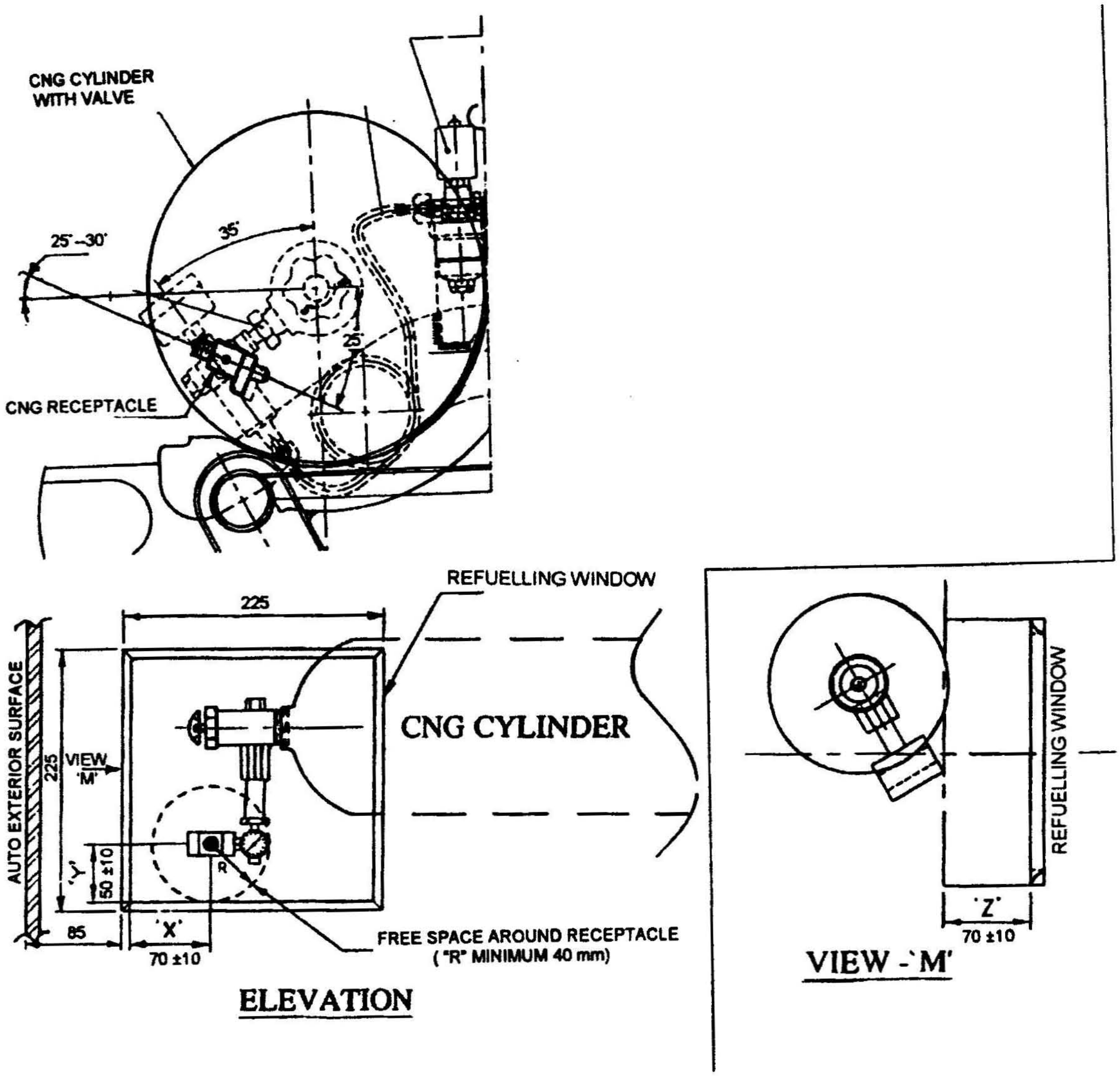
4.3.7 *Excess Flow Valve*

A device may be fitted in the fuel line preferably at the inlet or outlet of the cylinder valve which prevents the total contents of the cylinder from discharging to atmosphere in the event of rupture to any part of the fuel line or components.

4.4 Location, Ventilation and Mounting of Cylinders

4.4.1 *Cylinders, Fittings and Pipe Work*

4.4.1.1 Cylinder shall be mounted in a protected location inside the perimeter of the vehicle. Cylinders shall not be located so that the vehicle driving characteristics are adversely affected.



All dimensions in millimetres.

FIG. 4 POSITION OF FILLING CONNECTIONS

4.4.1.2 *For Externally Mounted Cylinders*

In no case shall cylinder valves be positioned less than 200 mm from the extremities of the vehicle unless they are protected to minimize the possibility of damage due to collision, overturning or other accident.

Where the operation of the vehicle is such, that the cylinder will be subjected to impact damage from loose metal or other objects being thrown up from the road, effective shielding against these shall be provided.

4.4.1.3 The cylinder shall be situated and vented so that any gas escaping due to leakage from the cylinder valve shall not enter the vehicle passenger compartment or driver space.

4.4.1.4 The clearance between the cylinder(s) and the exhaust shall not be less than 75 mm.

4.4.1.5 *For Heavy Motor Vehicles Only*

In the case of heavy motor vehicles, the number of cylinders likely to be required will be of sufficient weight to affect the legal maximum vehicle weight constraints. The effects of the chosen position of the cylinders on the following criteria must be assessed, and if necessary, a reduction in the allowable payload of the vehicle under study be considered:

a) The original manufacturer's maximum design axle loadings.

b) The maximum allowable axle loadings.

c) The maximum gross vehicle weight and/or gross combination weight allowed by the original manufacturer.

A number of alternative cylinder mounting positions may have to be considered in order to minimize the effects mentioned above. The effects of removing or replacing existing diesel fuel tanks on weight distribution of the vehicle should also be taken into account in the above calculations.

NOTE — Vulnerability of cylinders and fittings to damage during loading and unloading of the vehicle or load shift or spillage shall be taken into account.

4.4.2 Fitting of Cylinders shall be such that:

a) Cylinder shall not be fitted in any position behind the driver seat (seat adjusted to rear most position), which will hinder the driver seat adjustment unless specifically approved by the testing agency.

b) Cylinder shall not be fitted in a position beneath the vehicle that decreases the effective ground clearance (*see* Fig. 5 for 4-wheeler below 3.5 tonne GVW).

c) In case of heavy vehicles (bus having more than 3.5 tonnes GVW), for fitment of cylinders on roof, the strength of roof shall be validated by testing agency based on design calculation provided by vehicle manufacturer/kit manufacturer/kit supplier.

4.4.3 *Vehicle Mounted Cylinders*

4.4.3.1 A cylinder installed in a vehicle shall be permanently mounted and filled in that position.

4.4.3.2 *Cylinder location ground clearance*

Cylinders shall be located in accordance with the following requirements:

a) The vehicle mass for determining ground clearance shall be the laden mass, including permanent non-standard attachments to the vehicle with all fuel, water and oil containers full.

b) Cylinders installed between and behind axles shall not be lower than the lowest of the following points and surfaces forward of the cylinder (*see* Fig. 5 for 4-wheeler below 3.5 tonnes and Fig. 6 for 4-wheeler and above exceeding 3.5 tonnes GVW and Fig. 7 for trailers):

1) The lowest structural component of the body.

2) The lowest structural component of the frame or sub-frame, if any.

3) The lowest point of the engine.

4) The lowest point on the transmission (including the clutch housing or torque

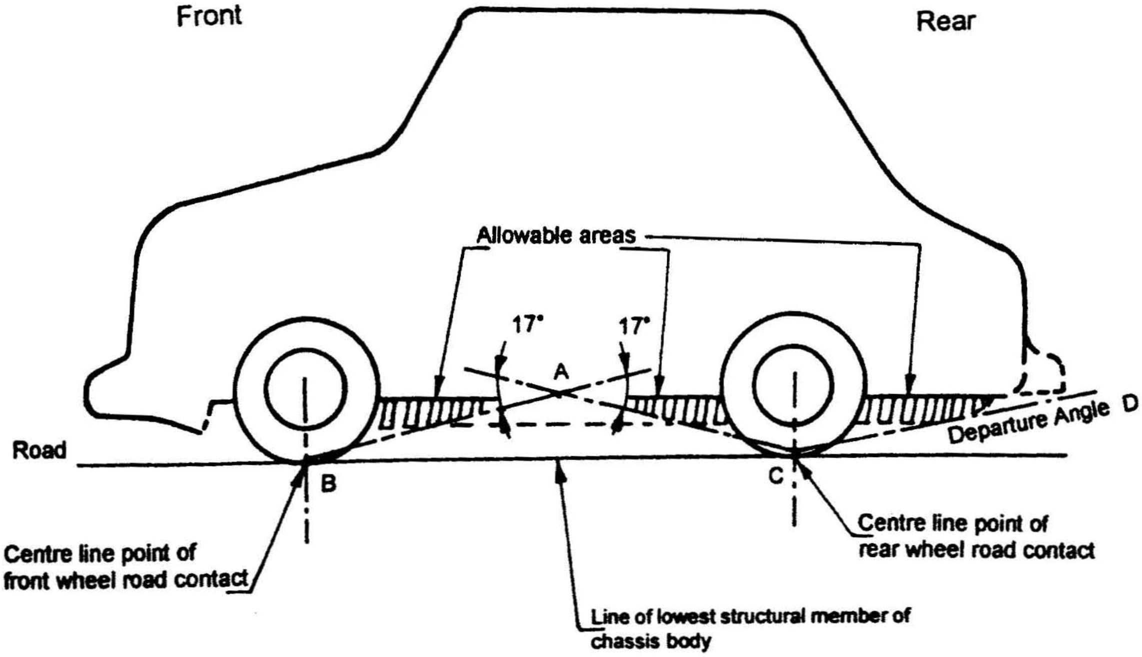

Front
Rear
Allowable areas
17°
17°
A
Departure Angle D
Road
B
C
Centre line point of front wheel road contact
Centre line point of rear wheel road contact
Line of lowest structural member of chassis body

FIG. 5 SCHEMATIC DIAGRAM SHOWING RAMP ANGLE AND GROUND CLEARANCE FOR MOUNTING OF CYLINDERS ON 4-WHEELED VEHICLES

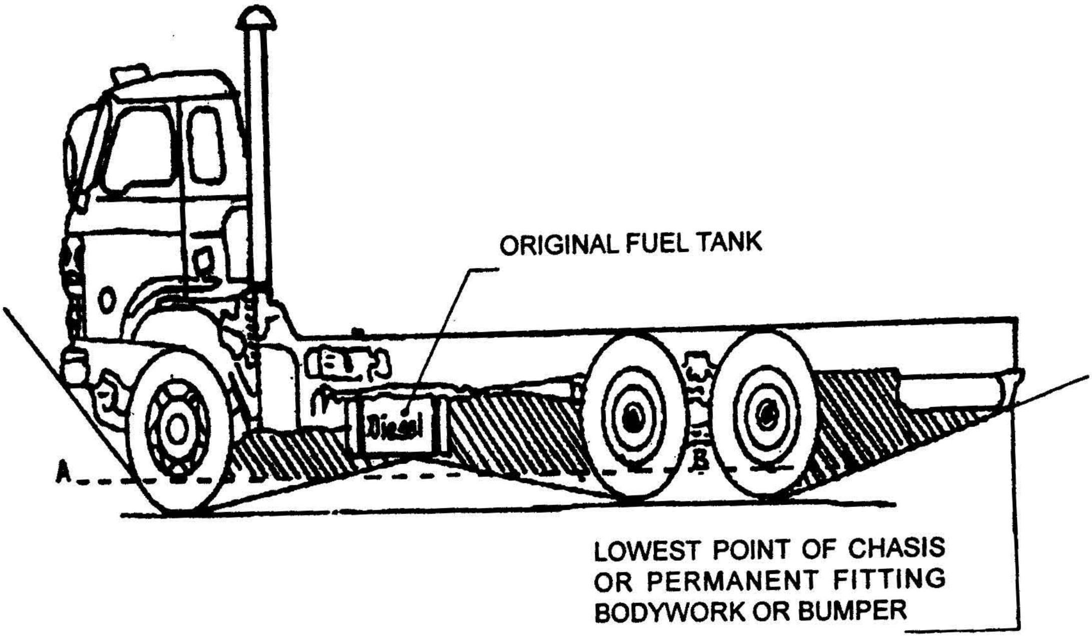


FIG. 6 TYPICAL POSITION OF ORIGINAL FUEL STORAGE TANK GROUND CLEARANCE

converter housing as applicable) but excluding differential housings.

5) The original fuel tank or tanks and/or brackets.

6) Approach and departure clearances shall be below planes defined in Fig. 6 (for 4-wheeler and above exceeding 3.5 tonne GVW).

NOTE — Suspension spring U bolts are not classified as structural components.

7) In any case the lowest point of the cylinders shall not be lower than a horizontal line taken at the lowest point of the front and rear wheel rims (line *AB* in Fig. 6) (for 4-wheeler and above exceeding 3.5 tonnes GVW).

c) Ramp angle (for 4-wheeler below 3.5 tonne GVW)

The cylinder(s) shall not be lower than a point defined by a ramp angle of 17° (*see* Table 1 for calculation).

Table 1 Zones of Clearance

[*Clause* 4.4.3.2(c)]

Sl No. (1)	Wheel Base mm (2)	Clearance Height at 17° Ramp Angle (Point *A* of Fig. 5) mm (3)	Sl No. (1)	Wheel Base mm (2)	Clearance Height at 17° Ramp Angle (Point *A* of Fig. 5) mm (3)
i)	1 800	134	xviii)	3 500	261
ii)	1 900	142	xix)	3 600	270
iii)	2 000	149	xx)	3 700	276
iv)	2 100	157	xxi)	3 800	284
v)	2 200	164	xxii)	3 900	291
vi)	2 300	172	xxiii)	4 000	298
vii)	2 400	179	xxiv)	4 100	306
viii)	2 500	187	xxv)	4 200	313
ix)	2 600	194	xxvi)	4 300	321
x)	2 700	202	xxvii)	4 400	328
xi)	2 800	209	xxviii)	4 500	336
xii)	2 900	216	xxix)	4 600	343
xiii)	3 000	224	xxx)	4 700	351
xiv)	3 100	231	xxxi)	4 800	358
xv)	3 200	239	xxxii)	4 900	366
xvi)	3 300	246	xxxiii)	5 000	373
xvii)	3 400	254			

NOTE — If wheel base measurement falls between any of the figures shown above then the next higher figure is to apply.

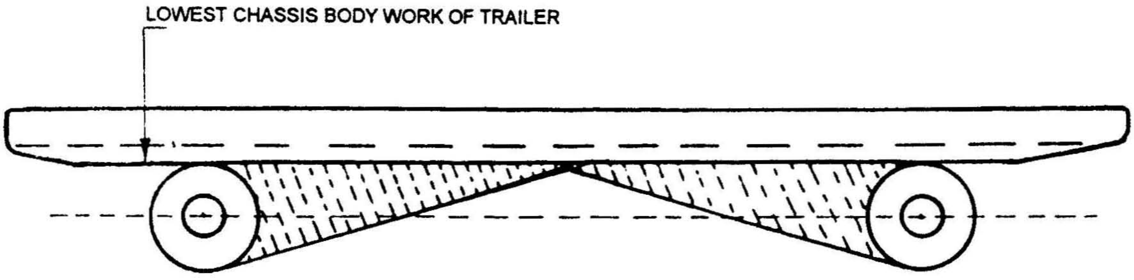


FIG. 7 TRAILER MOUNTING OF CYLINDERS GROUND CLEARANCE

To calculate ramp angle the following measurements shall be taken:

1) A plane through the centre line point of road contact of the front wheel (point *B*), sloping upward to contact the lowest structural point of the vehicle midway between the axles (point *A*) (line *AB* in Fig. 5); and
2) A plane sloping from point (*A*) defined in (1) downward to the centre line point of road contact of the foremost rear axle wheel (point *C*) (line *AC* in Fig. 5).

d) Departure angle (for 4-wheeler below 3.5 tonne GVW)
   1) The cylinders shall lie within an area *C-D* in Fig. 5.
   2) When calculating departure angle the measurement shall be taken along angular plane tangential to the centre line point of road contact of the rear most axle wheel sloping upward and outward to the extremity of the permanent body work or original equipment bumper bar whichever is the lower.
e) All clearances shall be measured to the bottom of the cylinder or to the lowest fitting, support or attachment on the cylinder or cylinder housing, whichever is lowest.

4.4.4 *Internal Cylinders*

Where a cylinder is located within the body shell of a vehicle, either:

a) the whole body of the cylinder together with its attached components and fittings shall be enclosed in a compartment; or
b) the valves and pipe connections associated with or attached to the cylinder shall be enclosed in a localized sub-compartment, which is attached to the cylinder and vented to the atmosphere. Provision shall be made for ready access to the cylinder valve in all installation arrangements.

NOTE — The luggage boot of a car is not considered to be acceptable as a cylinder compartment under (a) above, because of difficulties concerning effectiveness of sealing, the maintenance of ventilation openings, and the presence of electrical equipment in most boots.

4.5 Cylinder(s) Installation

For construction equipment vehicles, *see* **4.12**.

4.5.1 *Attachment to Vehicle* [*see also* **4.5.1**(e)]

Cylinders shall be securely attached to the vehicle to prevent slipping; rotating and jarring loose, in accordance with the following requirements (*see Fig*. 8 and *Fig*. 9):

a) The method of attachment shall not cause undue stresses or wear in the cylinder shell;
b) The mounting method shall not significantly weaken the vehicle structure, and reinforcement shall be added where necessary to ensure compliance with (c) below. An air gap of not less than 5 mm shall be provided between the cylinder and vehicle structure and in between cylinders.
c) The force necessary to separate the cylinder from the vehicle shall not be less than 20 times the mass of the full cylinder in any direction.

   The strength of the anchorages may be established by static test (forces directed through the centre of mass of the cylinder).
d) In the absence of testing or where calculations are impracticable, the following design requirements shall apply:
   1) There shall be at least 4 points of attachment to the vehicle structure. The spacing between these shall be sufficient to ensure the stability of the cylinder. These bands shall not mask the

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identification markings of the cylinder.

2) Where a cylinder is anchored to steel sheet metal the sheet metal shall be reinforced by a plate of not less than 3600 mm^2 and a thickness of not less than 2.5 mm or appropriate thickness supported by the calculation or test report. It is preferred that a round washer be used but where a square plate is fitted the corners shall be rounded. Any such reinforcement plate/washer shall be contoured to the shape of the sheet metal or chassis rail.
3) Where anchorage bolts pass through a hollow section, provision shall be made to prevent collapse of that section under load.
4) Anchorage bolts or studs shall have a diameter not less than that shown in Table 2 and shall conform to strength grade 8.8 of IS 1364 (Part 1) and nuts also to IS 1364 (Part 3).
5) Where clamping bands are used, at least two steel bands per cylinder shall be provided, the dimensions, of which shall not be less than those in Table 2.
6) Where the attachment is by means of clamping bands there shall be a positive means of resisting end loads on the cylinder by means of providing suitable end stoppers.
7) Screwed fasteners or clamping devices shall either be inherently resistant to loosening or be locked or pinned after tightening.

e) The chassis of heavy motor vehicles can be subjected to considerable torsional and bending deflections even under normal operating conditions. Mounting of cylinders to chassis rails must take these deflections into account and the cylinder mounting method chosen must not unduly prevent these deflections occurring.

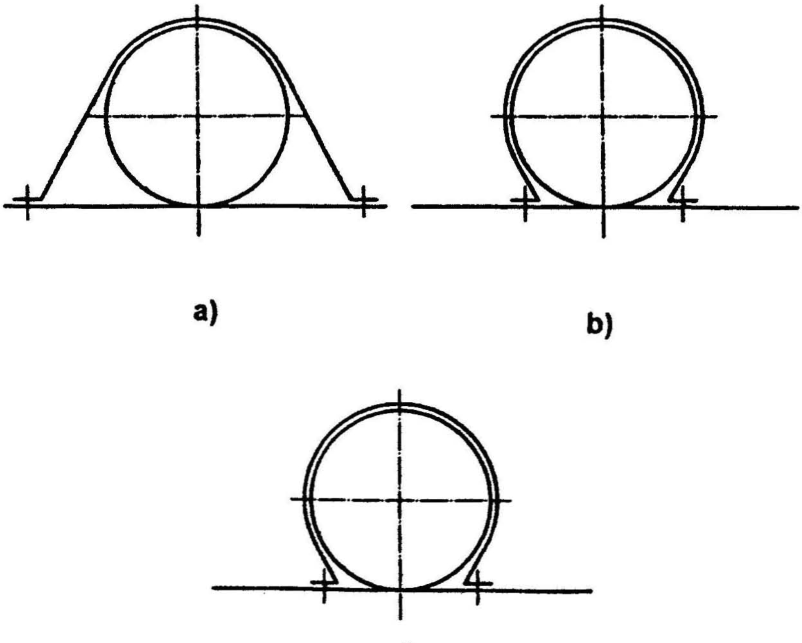
In addition, many chassis manufacturers specifically prohibit the welding of attachment points to their chassis members and in some cases also prohibit the drilling of additional mounting holes in the chassis members. For any proposed chassis modification due consideration must be given to the particular chassis manufacturer's restrictions with respect to welding, drilling and sealing of existing holes. Advice on these matters can be obtained from the chassis manufacturer.

4.5.2 *Cylinder Manifolding*

Where more than one cylinder is fitted to a vehicle it is preferable the cylinders are connected together in such a way that all can be simultaneously filled from any fill point on the vehicle. Each cylinder shall retain its required individual cylinder valve.

4.5.3 *More Than One Cylinder*

Specific design may be required for the mounting attachment.

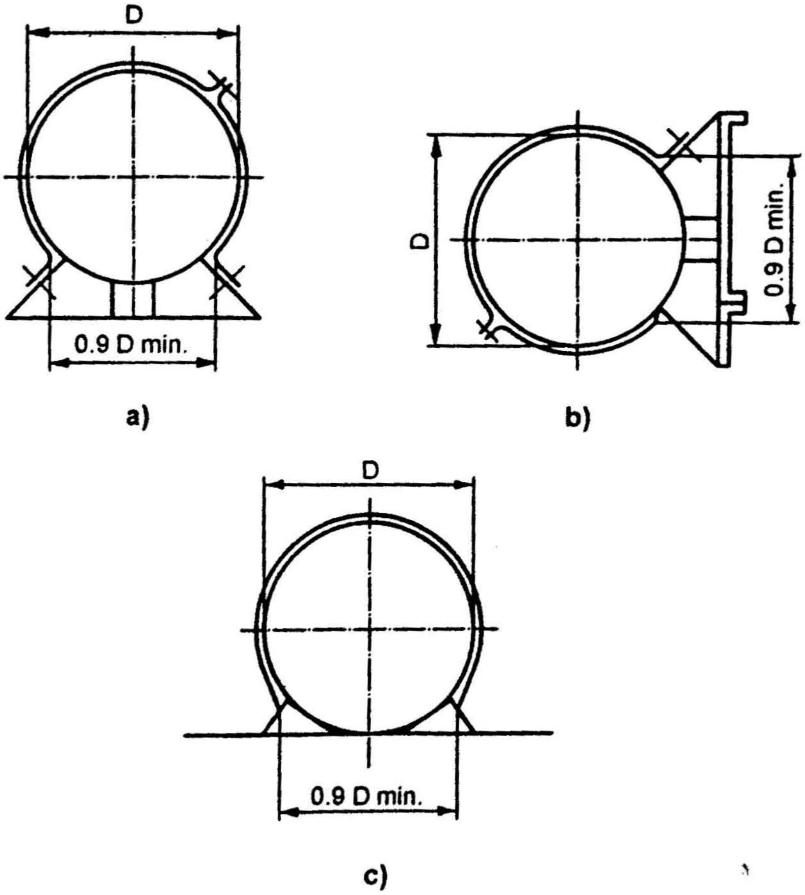


a)

b)

c)

FIG. 8 UNACCEPTABLE ARRANGEMENTS OF CYLINDER BANDS (NON-EXHAUSTIVE EXAMPLES)



a) b) c)

FIG. 9 TYPICAL PREFERRED ARRANGEMENT OF CYLINDER BANDS

Table 2 Band and Bolt or Stud Dimensions
[*Clause* 4.5.1 (d) (4) *and* (5)]

Sl No.	Cylinder Size (Water Capacity) Over, Up to and Including litre	Band Dimensions — Minimum Nominal Size mm	Bolt or Stud Diameter for Strap or Flange Mountings Minimum Nominal Size mm
(1)	(2)	(3)	(4)
i)	0-30	30 × 2	10
ii)	30-100	30 × 3	10
iii)	100-150	50 × 6	12
iv)	Above 150	Specific design required	—

NOTE — To prevent possibility of external corrosion where clamping bands are used, check that the material of the padding/lining provided for inner side of cylinder mounting band(s) is made up of EPDM rubber (hardness Shore A 60, *Min*) as approved by the test agency during type approval certification. Similar adequate protection to the cylinder shall also be provided wherever the cylinder rests against other metal objects such as the mounting frame.

4.5.4 Cylinder identification markings should be capable of being read when in the installed position.

4.6 Shielding

Cylinders shall be installed to ensure that valves and connections on cylinders shall be protected to minimize the possibility of damage due to accidental contact with stationary objects or from loose objects thrown up from the road. Valves shall be protected to minimize the possibility of damage due to collision, overturning, or other accident. Parts of the vehicle may be used to provide such protection to valves and fittings.

4.7 Construction of Compartments and Sub-compartments

4.7.1 A cylinder compartment or sub-compartment shall comply with the following requirements and shall meet component test requirements as per IS 15720.

a) Construction shall be such that any gas which might leak from any fittings, component or piping, can not pass to any other enclosed compartment, passenger space or luggage space of the vehicle.

b) It shall be possible to operate the cylinder service shut-off valve in the installed position. The valve may be arranged so that it can be operated from some internal area of the vehicle provided that the sealing of the compartment or sub-compartment shell is maintained by one of the following means, as appropriate:

   1) If a valve actuating device passes through the shell a gas-tight seal shall be provided.

   2) If the actuating handle is wholly within the shell, access shall be a gas-tight captive hatch. The design shall not need tools to open the hatch.

c) A compartment or sub-compartment shall not contain ignition sources or electrical equipment or wiring unless it is intrinsically safe.

4.7.2 *Ventilation*

One or more vents to the outside of the vehicle shall be provided, the aggregate area of which shall not be less than 550 mm^2 for vehicles other than 2 and 3 wheelers and 250 mm^2 for 2 and 3 wheelers. The vent line shall be so located as to exhaust any gas, which may accumulate in the compartment or sub-compartment to atmosphere and shall not exit less than 75 mm from an exhaust pipe or other heat source [*see also* **4.7.3.1** (c)]. Holes for venting shall be positioned not less than 40 mm from the edge of a panel or a welded joint or direct load bearing point.

4.7.3 *Ducting*

4.7.3.1 All piping or hoses that pass through an enclosed area of the vehicle shall be within a conduit gas-tight from the vehicle interior, vented unobstructed to outside atmosphere and protected from external damage and shall meet component test requirements as per IS 15715 and comply with the following requirements:

a) The ducting shall be as short as practicable.

b) The connections shall be mechanically clamped and shall not depend on adhesives or sealing compounds to retain them in place. Protection in the form of a gasket shall be provided to prevent damage to the ducting material by the clamping device.

c) The material of the conduit used for ducting shall be sufficiently strong to resist mechanical damage, preserve venting integrity, protect the piping or hose within it, shall not support combustion.

4.7.3.2 *Pliable material*

A sub-compartment may be constructed of pliable material attached to the cylinder so that the cylinder valve, piping and connections are contained within the sub-compartment. The pliable material shall meet the requirements of this clause and shall be clearly marked accordingly.

4.7.3.3 Where the sub-compartment is removed to initiate repairs or at the periodic inspection special attention shall be given to the inspection of the material to ensure that no degradation of material has taken place. Any sub-compartment showing signs of degradation shall be replaced.

4.7.3.4 The cylinder valve actuating device position shall be clearly identified and shall have provided adequate material to allow closing of the valve without damage to the sub-compartment sealing.

4.7.3.5 The pliable sub-compartment shall be shielded or installed in a protected location to prevent damage, from unsecured objects and abrasion. The material shall be sufficiently strong to resist mechanical damage, preserve venting integrity, shall not support combustion.

4.8 CNG Fuel Line

4.8.1 *CNG Fuel Line — Pressure Exceeding 100 kPa (High Pressure Fuel Line)*

4.8.1.1 Rigid piping and connections for use with pressures exceeding 2.15 MPa shall conform to IS 15716.

4.8.1.2 CNG fuel line and connections for use with pressures exceeding 100 kPa but less than 2.15 MPa shall conform to IS 15722.

4.8.1.3 *Flexible hose exceeding 2.15 MPa*

4.8.1.3.1 Flexible hose shall meet the requirements of IS 15718. Each flexible hose assembly shall be permanently and clearly marked with the manufacturer's name and trade-mark, type, size and design working pressure. It shall be identifiable as being suitable for CNG use either by marking it with 'CNG' or with a specification mark.

4.8.1.3.2 *Installation*

4.8.1.3.2.1 The hose shall be supplied and fitted as a fully made up assembly.

4.8.1.3.2.2 In addition to the requirements of **4.8.1.5**, flexible hose shall be installed in accordance with the following requirements:

a) The bend radius of the hose shall not be less than 35 mm or the manufacturer's recommended specifications.

b) Flexible hose shall be secured to the chassis frame or vehicle body by clips, secured at not more than 300 mm apart and shall be fitted prior to and after each bend.

c) Such clips shall be of sufficient resilience and secured to the vehicle in such a manner so as to prevent lateral movement and damage to the hose and not work loose.

d) The hose shall be located as far away as practicable from the exhaust system. In no case shall it be closer than 100 mm. Where the hose is situated between 100 mm and 200 mm from the exhaust, shielding shall be provided which shall take the form of one piece of sheet metal located midway between the exhaust and fuel line.

NOTE — The exception being the flexible hose used between the towed and towing vehicle.

4.8.1.3.3 *Inspection*

4.8.1.3.3.1 The hose shall be inspected for twists, kinks and damage or abrasions to the cover, which expose the wire. The hose shall be condemned on detection of any one of these defects.

4.8.1.3.3.2 At no time shall flexible hose be placed back into service after removal from the vehicle, the exception being flexible hose designed for and used between the towed and towing vehicle.

4.8.1.4 *Joints and connections*

4.8.1.4.1 Every joint or connective filling in rigid high pressure fuel line shall be as per IS 15716.

4.8.1.4.2 The number of joints and connections shall be the minimum for the inclusion of all components.

4.8.1.4.3 Joints or connections in a CNG fuel line shall be in accessible positions for easy inspection.

4.8.1.4.4 Connection means shall provide positive retention of the fuel line in the fitting (for example, by double inverted flaring of the tube end or by ferrule type compression fitting).

4.8.1.5 *Securing and location*

High pressure piping and hoses in vehicles shall comply with the following:

a) No CNG fuel line inside the part of any vehicle occupied by the driver or passenger shall be outside the sealed and vented enclosure (except as provided for in **4.7.3**).

b) All CNG fuel lines shall be positioned for protection from the possibility of damage by impact, accident or loose objects thrown by the vehicle wheels/tyres. Parts of the vehicle may be used to provide such protection.

c) CNG fuel lines shall not be located inside box sections or in other inaccessible locations nor shall they be installed in any location, which is not adequately protected from sources of heat, abrasion, or from impact.

d) Use of the drive shaft tunnel for fuel line location is not desirable or recommended. If such routing is the only possible practicable method of installation, the fuel line must be positioned along the lower corner of the tunnel with the underside of the fuel line not more than 15 mm above the intersection with the floor pan. The fuel line should follow this route for the shortest distance possible. The fuel line shall have a minimum clearance of 40 mm with the drive shaft under all operating conditions. This method is not applicable to vehicles where the open axle shaft passes through a tunnel.

e) Use of the wheel arch for fuel line location is not desirable or recommended.

f) Fuel lines shall follow the shortest practical route taking into account the requirements of **4.8.3.2**.

g) Rigid fuel lines shall be effectively secured to the chassis frame or vehicle body by clips spaced not more than 300 mm apart for 2 and 3 wheeler and 600 mm apart for other vehicles. In order to prevent the possibility of fretting corrosion or erosion of the fuel line cushioning must be provided to protect the fuel line from both the chassis/body and the clips themselves. Suitable grommets must be provided where the fuel line passes through any body panel.

h) Manifolds used in multi-cylinder applications shall be installed in a protected location. Manifold branch pipelines shall be sufficiently flexible to prevent damage to the lines, valves and fittings due to vibration, expansion or contraction.

j) In no case shall the clearance between the exhaust system and the fuel line be less than 75 mm.

k) Fuel lines shall not be installed where any part will be permanently hidden from sight or can not be inspected or easily replaced (except as provided for in **4.7.3**).

4.8.2 *CNG Fuel Line — Pressure Below 100 kPa (Low Pressure Fuel Line)*

All CNG fuel lines for use for service pressure not exceeding 100 kPa (low pressure hose) shall be of flexible material and shall meet requirements of IS 15722. Joints and connections for low pressure fuel lines shall be suitable for use with CNG and shall meet requirements of IS 15722.

4.8.3 *Flexibility*

4.8.3.1 Low pressure hose shall be of sufficient length to accommodate engine movement.

4.8.3.2 High pressure fuel line shall be installed so as to accommodate any relative movement between chassis/body and fuel system components or temperature variations in the fuel line.

4.8.3.3 All runs of rigid fuel line piping between any two components shall be installed with a 'pigtail' or U bend to provide this essential flexibility (*see* **4.8.3.2**). The dimension for U bend shall be not less than 50 mm radius at the bend portion of U or 100 mm diameter for the pig tail coil and number of coils shall not be more than two.

4.8.4 *Trailers and Semi-trailers*

The fuel supply line between cylinders and engine shall not pass between a towed and a towing vehicle unless the following conditions are satisfied:

4.8.4.1 *Low Pressure Transfer of CNG*

a) The cylinder pressure shall be reduced to 2.15 MPa (*Max*) by use of a primary regulator placed upstream of the towing connection. All such equipment should be recommended for this application by the equipment manufacturer.

b) All components downstream of the primary regulator must be protected against pressure rise due to failure of any other component by the use of a relief valve which will prevent the pressure experienced downstream of the primary regulator from rising above 3.3 MPa.

c) CNG fuel line connecting the towed and towing vehicle shall be flexible hose and shall meet the requirements of IS 15718.

d) The flexible fuel line shall be arranged and installed so that the free movement of the hose between towed vehicle and the breakaway coupling shall be minimum required to accommodate all possible movement with the towing coupling engaged.

e) A breakaway coupling shall be provided within the connection of the flexible hose between towed and towing vehicle and the rigid fuel line installed on the towing vehicle. The coupling shall be attached to the towing vehicle in such a manner so as not to impede its operation and shall resist, without permanent deformation of the attachment, a proof load of 50 kgf in the forward and reverse direction of travel of the vehicle.

f) Hose couplings shall be of the failsafe or dry type having internal valves which prevent the loss of fuel when breakaway occurs or when the coupling is undone.

g) The fuel line upstream of the breakaway coupling must be protected by an accessible manually operated isolating valve. If cylinders are present on a towing vehicle an accessible manually operated isolating valve shall also be fitted on the towing vehicle.

NOTE — The allowable amount of free movement of hose between the towing and towed vehicle shall be such as to minimize whipping of the hose should the hose be severed.

4.8.4.2 *High pressure transfer of CNG* (*see* Fig. 10)

Where high pressure CNG is transferred between the towing and towed vehicle, **4.8.4.1** (c), (d), and (g) shall apply along with the following:

a) A quick-connect coupling shall be provided within the connection of the flexible hose between towed and towing vehicle and the rigid fuel line installed on the towing vehicle.

b) For any tractor unit provided with CNG storage cylinders, the system shall have installed on the tractor as close as practicable to the coupling a check valve to prevent flow of gas from the cylinders on the tractor through the coupling.

c) The system shall have installed on the trailer downstream and as close as possible to the quick connect coupling, a manual venting valve, having 3 ports. The valve shall be fitted in such a way that in one position the flow of gas from the cylinders through the excess flow valve will be permitted while in the other position the fuel line from the cylinders is isolated and the line through the coupling, is vented to atmosphere. A permanent label shall be provided 'MANUAL VENTING VALVE' in such a way as to clearly indicate the position and function of the valve.

d) The manual venting valve is to be operated before the disconnection of the coupling thus releasing pressure from the coupling and fuel line between the check valve in the line of the towing vehicle and the manual venting valve. This venting operation is to be conducted in an open, well ventilated space at least 15 m from any naked flames or other source of ignition.

e) A plate shall be permanently attached to the fuel line next to the coupling and shall be marked as follows: 'DANGER: NO SMOKING. PRIOR TO UNCOUPLING, RELEASE LINE PRESSURE AT MANUAL VENTING VALVE'.

NOTE — The allowable amount of free movement of hose between the towing and towed vehicle shall be such as to minimize whipping of the hose should the hose be severed.

4.9 CNG Control Equipment

4.9.1 *Definition*

4.9.1.1 The CNG fuel control equipment includes all the equipment necessary to convert CNG at high pressure at the cylinder to CNG air mixer for supply to the engine and shall meet requirements of IS 15712, IS 15713, IS 15714 and IS 15717.

In case of heavy motor vehicle, engine control equipment includes all the equipment used to convert a compression ignition engine to run on a gaseous fuel. This includes devices such as fuel provision and control device, the ignition system (if one is used), the speed and/or load governing device (if any), and any engine protection devices such as temperature and pressure alarms, and knock detection systems.

4.9.2 *Control Equipment*

4.9.2.1 *Filter*

At the termination of every CNG service fuel line immediately prior to any regulator component there shall be a properly designed filter capable of removing all particulate matter from the fuel that could cause malfunction of such regulator components.

4.9.2.2 *CNG shut-off valve*

4.9.2.2.1 This valve shall shut-off fuel supply to the engine when activated by the fuel change over control on bi-fuel operation and by the ignition switch on single fuel operation. Normally this is a regulator component but in any case it shall be located downstream of the filter. This valve shall automatically shut-off the fuel supply to the engine unless the following conditions are satisfied:

a) The ignition is on; and

b) The engine is turning.

4.9.2.2.2 *Service shut-off valve*

A service shut-off valve shall be installed in the high pressure line between the cylinder valve and any other valve or component within the engine compartment and as close as practicable to the regulator, however it is acceptable to install the valve at the refueling point. It shall be possible to readily operate the valve in the installed position at all times in particular during the refueling operation. A permanent label shall be provided 'CNG service shut-off valve' or similar wording to positively indicate its purpose and a positive indication of "Closed" and "Open" positions of the valve shall be clearly marked.

4.9.2.3 *Regulator system*

4.9.2.3.1 The regulator system shall not permit gas to pass after the engine has stopped turning, irrespective of whether the ignition is on or off. The regulator shall be installed so that,

a) It is securely mounted as far as practical from the extremities of the vehicle.

b) It is mounted securely and as close to the engine Gas Air Mixer position as convenient.

c) It is easily accessible for routine maintenance, adjustment and inspection.

d) It is situated as far from the exhaust system as practical. Where this distance is less than 150 mm it shall be shielded from radiant heat and any impingement from exhaust gases due to exhaust system failure.

e) It is reasonably protected from impact in a collision.

f) It allows sufficient free movement of all hoses.

g) The water circulating system (where required) is connected in accordance with the manufacturer's instructions, and no flow control valve in the system can shut-off original equipment water flow.

h) Where possible, the regulator should be at lower level than top of the radiator, as insufficient water may cause freezing (*see also* Annex A for precautions against freezing).

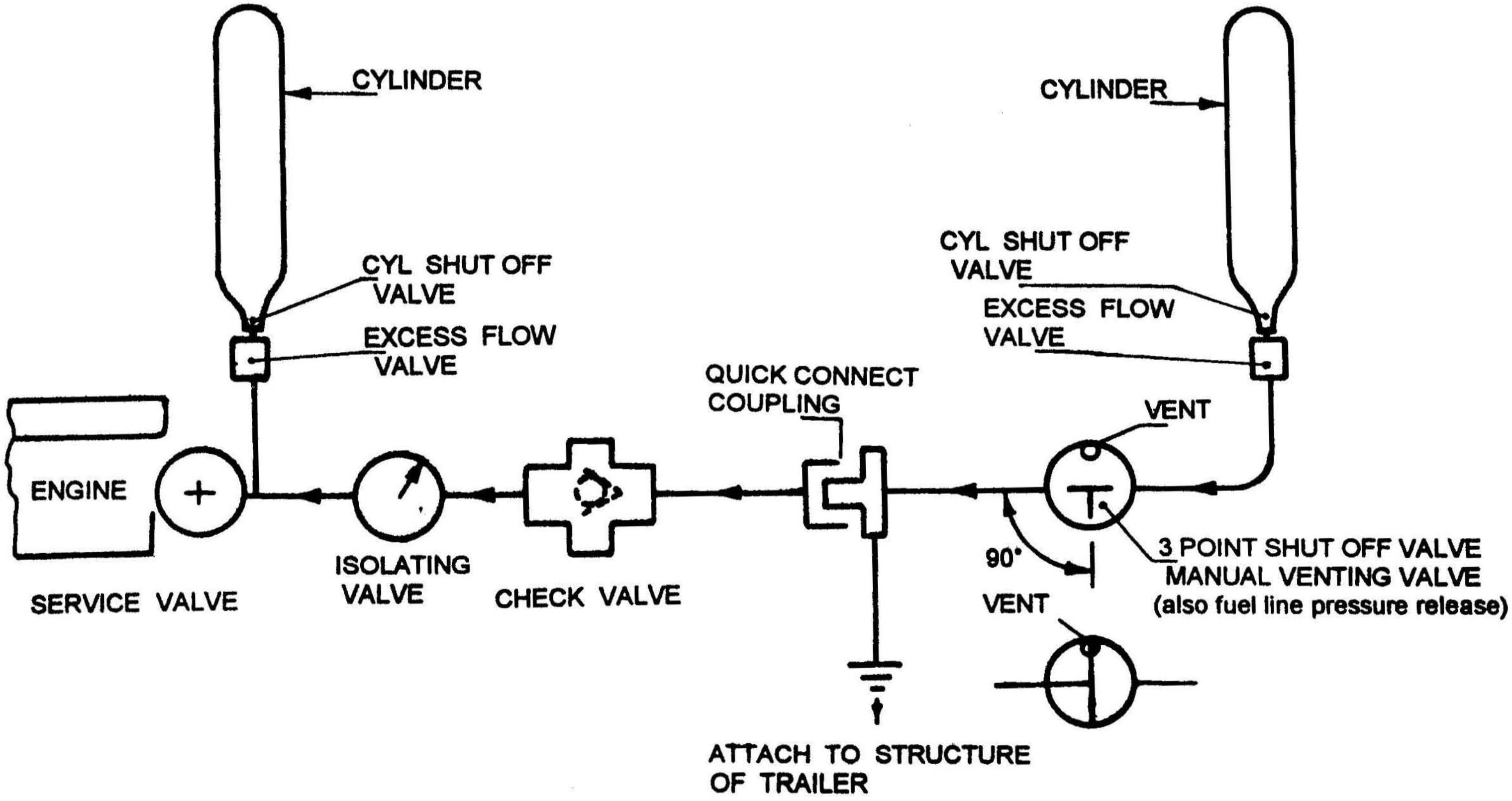


FIG .10 DIAGRAMMATIC ARRANGEMENT OF VALVING IN FUEL LINE BETWEEN TRAILER MOUNTED CYLINDERS, TRACTOR MOUNTED CYLINDERS AND ENGINE IN HIGH PRESSURE TRANSFER

4.9.2.3.2 The regulator assembly shall not be attached to the engine assembly unless otherwise specified by the manufacturer and then shall be fitted only in accordance with the manufacturer's recommended instructions.

4.9.2.4 *Gas air mixer*

4.9.2.4.1 A backfire deflector to arrest backfire shall be installed in the air intake immediately prior to the mixer. The back-fire deflector shall meet the requirements of Annex B.

In case of heavy motor vehicle, there shall be installed in the air intake prior to the mixer a backfire deflector (original air filter acceptable). In turbo charged applications where rigid piping is fitted from the turbo charger to the intake manifold a pressure relief valve shall be fitted as close as practicable to the intake manifold. Where a volume of gas/air mixer, due to turbo charging or inter/after coolers is contained downstream of the mixer, special precautions will need to be applied to avoid damage to components downstream of the mixer due to backfire.

Vehicle manufacturer/kit manufacturer/kit supplier shall submit test report or certificate complying with the above requirement. It is not necessary to carry out the test if declaration is submitted.

4.9.2.4.2 The mixer shall be securely mounted and when remotely fitted shall be suitably bracketed to support its own weight and applied working forces.

4.9.2.4.3 There shall be no air filter element fitted downstream of the gas air mixer.

4.9.2.5 *Bi-fuel/dedicated fuel system*

4.9.2.5.1 a) *Bi-fuel type* — A bi-fuel system is defined as a system equipped to operate with either on CNG or some other fuel for example petrol.

b) *Dedicated fuel type* — A dedicated system is defined as a system equipped to operate wholly on CNG.

4.9.2.5.2 *For bi-fuel type*

4.9.2.5.2.1 A shut-off device shall be installed in the bi-fuel fuel system. This device shall shut-off the optional fuel supply to the engine when this fuel is not required.

4.9.2.5.2.2 If the shut-off device is in the form of a solenoid operated shut-off valve it must be fitted between the fuel pump and the carburettor. The valve shall be mounted securely so that its weight is not transferred to any part of the carburettor or fuel lines.

4.9.2.5.2.3 Where the shut-off device is mounted remotely from the engine, flexible hose shall be used of sufficient length to accommodate engine movement. In all cases the device shall be mounted in a position reasonably protected from damage in a collision and shall be as far as practicable from high tension electrical equipment.

4.9.2.5.3 *Bypass relief device*

A bypass relief device shall be installed in the fuel pump or between the fuel pump and the automatic shut-off valve in the liquid fuel line to the carburettor on vehicles equipped with bi-fuel systems for the use of petrol and gaseous fuel. The relief device need not be installed on fuel pumps containing a bypass relief device as original equipment.

4.9.2.5.4 *Fuel selection control*

A fuel selection control shall be provided which shall have at least three positions, clearly marked for the selection of each of the two fuels. The selection control shall be placed within easy reach of the driver or operator. For vehicles fitted with electronic fuel injection, a two-position switch is acceptable.

4.9.2.6 *Installation*

The CNG control equipment shall be,

a) installed in positions that are accessible for routine inspection, maintenance and adjustment.
b) mounted securely and reasonably protected from damage in a collision.
c) remote from the vehicle engine exhaust system or protected therefrom by a metal shield.
d) no closer than is avoidable and practicable to any electrical equipment capable of sparking.

4.9.3 *Electrical Wiring*

4.9.3.1 All wiring shall be properly installed, taped, clipped or contained in a loom along its length.

4.9.3.2 Wiring cables shall comply with the requirements of IS 15719. The kit supplier/kit manufacturer or vehicle manufacturer shall submit test certificate/test report complying with requirements of IS 15719.

4.9.3.3 The electrical circuit shall be provided with a current limiting device conforming to IS 15723. This equipment or fuse shall be dedicated to the CNG fuel system.

4.9.3.4 *Connectors and terminals*

Connectors and terminals shall be insulated to prevent accidental earthing during operations or routine servicing.

4.9.4 *Pressure Indicator*

4.9.4.1 A pressure indicator to indicate pressure in the CNG gas cylinder shall be fitted in an easily visible position to service personnel at the regulator or fill point preferably within the engine compartment.

4.9.4.2 A supplementary gauge or electronic gauge may be placed in the driver's compartment provided any gauge shall be gas isolated from the cylinder or piping to prevent gas leaking into the compartment.

4.10 Compliance Plate

The compliance plate, displaying the following information, shall be installed near the filling connection and be clearly visible to the re-fueler:

a) CNG cylinder identification number(s),
b) Date of installation,
c) Water capacity (litre) of the individual cylinder,
d) Water capacity (litre) of the total installation,
e) Date of the last test,
f) Vehicle registration/Identification No.,
g) Next due date of testing, and
h) Installed by.

NOTE — The CNG installation complies with the safety requirements of this standard.

4.11 Labels

4.11.1 *Identification Labels*

Vehicles using a CNG system shall be labeled as follows:

Labels conforming with the specification given in **4.11.2** and **4.11.3** shall be affixed in a vertical position as close to the vehicle number plate as practical or on the left side of the front and rear safety glass and shall ensure visibility from the front and rear sides.

4.11.2 The label shall be in position at all times, shall be in good condition and the shape, colour and lettering shall be easily identifiable.

4.11.3 Label shall be coloured white and sized 80 mm x 80 mm diamond shape (*see* Fig. 11 for drawing). Label shall have on it the text "CNG" in black colour, centrally positioned. The label shall have a black border 1 mm wide, 5 mm inside the outer edge and running parallel to it. The 80 mm dimension is measured from the outer edge.

4.12 Construction Equipment Vehicles (Special Requirements)

4.12.1 *General*

4.12.1.1 This section covers the special requirements of construction equipment vehicles.

4.12.1.2 CNG fuel system installation on construction equipment vehicles shall comply with the requirements of this standard subject to the allowable variation detailed in this section.

4.12.1.3 Clauses of this standard which are not applicable to construction equipment vehicles and which are not clearly identifiable as such are as follows:

a) Location, ventilation and mounting of cylinders (*see* **4.4**);
b) Construction of compartments and sub-compartments (for internally mounted cylinders *see* **4.4.4.1** and **4.4.4.2**) (*see also* **4.7**);
c) Cylinder installation (*see* **4.5**); and
d) Securing and location — [except paragraphs (a) to (f) inclusive and (j)] (*see* **4.8.1.5**).

4.12.2 *Cylinders and Fittings, Location and Mounting*

4.12.2.1 *Location*

4.12.2.1.1 A fuel cylinder shall be so located as to minimize the possibility of damage to the cylinder or its fittings and it shall not be located so that it adversely affects driving characteristics of the construction equipment vehicles.

4.12.2.1.2 A cylinder shall not be fitted in any internal location when a suitable external location is available.

4.12.2.1.3 A cylinder and its fittings shall not extend beyond the platform of the vehicle.

4.12.2.2 *Clearance*

A fuel cylinder shall be installed with as much ground clearance as is practicable, but never less than the minimum ground clearance of the vehicle in the vicinity of the cylinder. This minimum clearance shall be measured to the bottom of the cylinder or the lowest cylinder fitting.

4.12.2.3 *Protection*

Valves and connections on cylinders shall be protected to minimize the possibility of damage due to accidental contact with stationary objects or from loose objects thrown up from the road. Valves shall be protected to minimize the possibility of damage due to collision, overturning or other accident. Parts of the vehicle may be used to provide such protection to valves and fittings.

4.12.2.4 *Shielding*

A fuel cylinder shall be shielded if necessary, against direct heat radiation from the engine and exhaust systems.

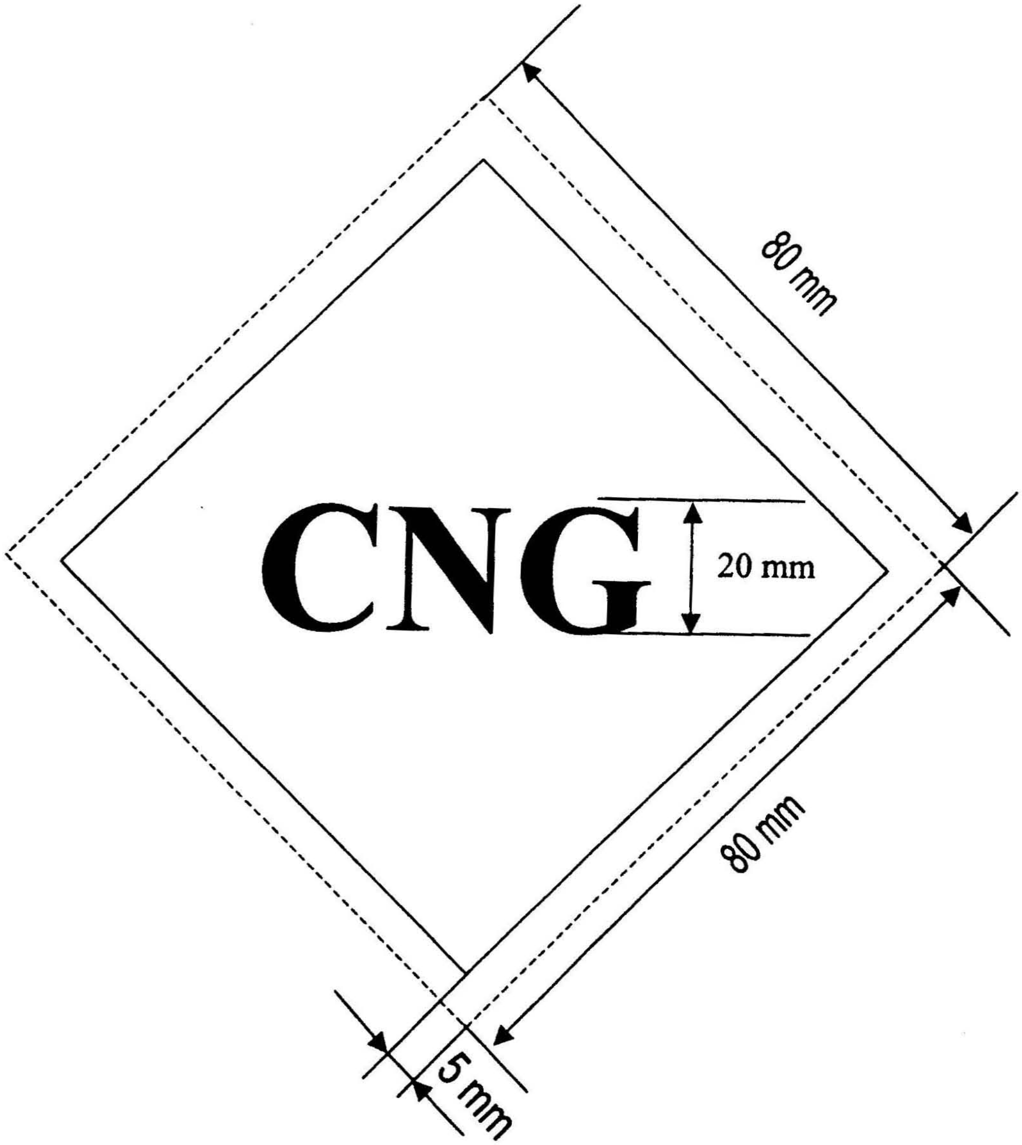


FIG. 11 LABEL

4.12.2.5 *Mounting*

A fuel cylinder shall be secured in place on the Construction Equipment Vehicles so as to meet the requirements of a loading test.

4.12.2.6 *Load test*

4.12.2.6.1 A CNG cylinder shall be secured in place on the construction equipment vehicles in a manner capable of withstanding, without visible permanent deformation, loadings in any direction equal to 10 times the filled weight of the cylinder.

4.12.2.6.2 For this test, the cylinder is to be empty of fuel and is to be secured in the manner covered by the manufacturer's instruction. Loadings are to be applied in any convenient manner capable of being measured by gauges or weights.

4.12.3 *Fuel System*

4.12.3.1 *Components*

All fuel system components shall be fastened to the construction equipment vehicle to minimize the possibility of loosening due to vibration.

4.12.3.2 *Securing and shielding*

Fuel lines shall be supported to prevent chafing and to maintain at least 50 mm clearance from exhaust and electrical system parts [*see* **4.8.1.5.1**(a) to (f) inclusive and (j)].

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4.12.4 *Shielding — Temperature/Pressure Tests*

4.12.4.1 The materials employed in the construction of construction equipment vehicles shall not be damaged by the temperatures attained during normal operation under the conditions of maximum rated load and under conditions of maximum overload maintained for a short period of time. The maximum temperature rise on the surface of any combustible material of electrical insulation shall not exceed 150°C.

4.12.4.2 The test period shall be that required to establish equilibrium conditions for temperature rise and pressure determinations, but shall be continued for not less than 2 h; except that a tractor shall be operated an additional 1 minute period against a bumping post or other obstruction, thereby causing the wheels to slip and the tractor to exert maximum draw bar pull in effect. During this additional one minute period, the rise in surface temperatures shall not exceed the limits specified.

4.13 Alteration or Modifications

Any alterations or modification to any vehicle to install equipment shall be carried out in accordance with sound engineering practices and in compliance with *Motor Vehicles Act*, 1988 and *Central Motor Vehicles Rule*, 1989 and their superseding amendment and notification issued thereafter. The following aspects shall be taken into consideration during alteration or modification:

Where modifications are made to:

a) *Suspension*: Mounting locations, geometry, ground clearance adjustment, axles and sub-axles, or steering mechanism.

b) *Original fuel storage*: The fuel tank assembly, fuel tank mounting, venting or filler assemblies.

NOTE — In some instances the fuel tank constitutes a structural member of the vehicle.

c) *Vehicle structure*: Holes greater than 13 mm shall not be located within 40 mm of the edge of a panel, welded joint or direct load bearing point (such as a belt anchor). The only holes permitted greater than 13 mm diameter are of the installation of the filling valve or for venting purposes.

d) *Braking system including the hand brake and components*: In this aspect, design guidelines supplied by vehicle manufacturers, vehicle safety standards of Indian or relevant standard, wherever applicable shall be referred.

NOTE — In case of the retro fitment, where modification types (a), (b), (c) and (d) are carried out to heavy motor vehicles these will require prior design approval from vehicle manufacturer.

5 INSTRUCTIONS TO BE PROVIDED BY THE CNG KIT MANUFACTURER/SUPPLIER

5.1 Clear, concise printed instructions and diagrams, stated in terms clearly understandable and adequate for proper assembly, installation, maintenance and safe operation, shall be made available by the manufacturer of the CNG kit component and component package.

5.2 Instructions for periodic maintenance of components, as required, shall be provided. Parts, which require replacement, shall be identified.

5.3 Printed instructions shall state that the installation shall be in accordance with the prevailing regulations of Government of India or, in the absence of which, in accordance with this standard.

5.4 This information shall be in an easily understood form.

5.5 An instruction manual shall be provided including specific instructions regarding CNG operation and alerting the owner to the cylinder inspection or expiration date.

6 CRITERIA TO AUTHORIZE THE KIT INSTALLER AND RESPONSIBILITY OF VEHICLE/KIT MANUFACTURER/SUPPLIER/ INSTALLER

6.1 The following are the criteria to be complied by the kit supplier/manufacturer for conversion of in-use vehicles to operate on CNG fuel.

6.1.1 The replacement of engine/retrofitment of CNG kit shall be type approved by any one of the testing agencies specified in Rule 126 of the *Central Motor Vehicle Rules*, 1989. The responsibility of the type approval and ensuring that the kits manufactured comply with the provisions and installation thereof shall be that of the vehicle/kit manufacturer/supplier as the case may be.

6.1.2 Only the installer authorized by vehicle/kit manufacturer/supplier shall fit the kit on vehicles. For this purpose, the vehicle/kit manufacturer/supplier shall issue a certificate of authorization to the installer concerned duly authorizing them to fit the kit on behalf of manufacturer.

6.1.3 Kit installer shall be equipped with the following tools and equipment:

a) Two post lift/ramp

b) Electric hand drill machine and H.S.S. drill bits

c) Tube bender
d) Tube cutter
e) Deburring tool for tube
f) Set of 'D' ring and box spanners
g) Set of screw driver (both flat and star)
h) Set of allen keys
j) H.S.S. hand saw
k) Crimping tool for electrical cable termination
m) Non-corrosive foaming agent
n) Set letter and number punch
o) Infrared pollution meter
p) Timing gun
q) Filler gauge
r) Measurement tape
s) Air compressor
t) Flame proof inspection light
u) Vernier caliper
v) Multimeter
w) Silicon seal/sealant
x) Fire fighting equipment
    1) Dry chemical powder (DCP) type fire extinguisher — minimum two numbers of 5 kg each with ISI Mark.
    2) CO_2 type fire extinguisher — minimum 1 number of 5 kg with ISI Mark.
    3) Fire buckets — 2 buckets.

6.1.4 Installer shall have trained technicians having minimum ITI qualification and at least two years of experience in the similar field. Vehicle/kit manufacturer/supplier to impart extensive training to the technicians on CNG kit installation.

6.1.5 Installer to display in the premises, authorization certificate issued by vehicle manufacturer/kit manufacturer/supplier. Also, installer to display details of the facilities available in terms of equipment and trained manpower.

6.1.6 After obtaining the type approval certification, the vehicle/kit manufacturer/supplier(s) shall authorize the installer to undertake CNG conversion, who meets the following requirements. The vehicle/kit manufacturer or supplier shall submit the following information to the regional transport authorities:

a) Name and communication details like address, telephone number, etc, of the installer;
b) Business profile;
c) Qualification;
d) Experience;
e) Details of technical staff and equipment; and
f) Specification of workshop/land use certificate from appropriate authority.

6.1.7 Installer to carry out conversion/installation as per the requirements of this standard.

6.1.8 Installer to carry out the inspection, testing, commissioning and garaging/repair of CNG system as specified in **6.2** and **6.3**.

6.1.9 Installer shall issue installation certificate as per Annex C to the vehicle owner, that the conversion kit has been fitted in safe and proper manner, in compliance with the requirements of this standard.

6.1.10 The record of conversion/alteration of vehicles carried out by the kit installer shall be maintained and made available to the authorities such as MoSRT&H (Ministry of Shipping, Road Transport and Highways)/Test Agencies/Transport Authorities as and when demanded.

6.1.11 The vehicle owner shall apply to the concerned registering authority within 14 days of undertaking the alteration, as required under Section 52 of *Motor Vehicle Act*, 1988 for endorsement of particular alteration in registration certificate mentioning place and date of installation and installation certificate number. This shall also be ensured by the kit installer.

6.1.12 The vehicle/kit manufacturer or supplier shall impart training to installer on installation, maintenance and operation of CNG system and issue the training certificate to installer after completion of training. The test agency may devise the appropriate training programme as required. The training shall encompass the following:

6.1.12.1 *CNG tank*

a) Fitments on tank,
b) Location and ventilation of tanks,
c) Construction of compartment and sub-compartment,
d) Installation of tank, and
e) Shielding.

6.1.12.2 *CNG fuel line*

a) Testing of CNG fuel line,
b) Flexibility, and
c) Installation.

6.1.12.3 *CNG control equipment*

a) Installation of regulator and its functioning, and
b) Installation of fuel selection switch and its information.

6.1.12.4 *Inspection, testing and commissioning of CNG system*

a) Commissioning, and

b) Leak testing.

6.1.12.5 *Garaging and repair*

a) Repair operation of CNG vehicles, and
b) Scrapping.

6.1.12.6 *Periodic inspection*

6.1.12.7 *CNG characteristics and safety aspects for handling and storage*

6.1.13 The kit installer shall ensure compliance to the emission norms of *CMV Rule* 115 (Sub-rule 2) and this standard.

6.1.14 Responsibility of the vehicle/kit manufacturer/supplier/installer: The owner/driver shall be instructed in the correct way the gas system and controls function along with a owners operation manual for the gas system outlining the following:

a) Basic gas system explanation with a diagram;
b) Fuel change over switch operation if bi-fuel system is fitted;
c) Starting procedure for cold and hot starting;
d) How the vehicle is refueled;
e) In the event of back-firing check procedure;
f) In the event of a gas leak shut-off procedure; and
g) Emergence or information contact numbers.

6.2 Inspection, Testing and Commissioning (for Installer)

6.2.1 *Commissioning*

Prior to initial use, an inspection of the CNG system and components shall be carried out by, or under the supervision of an Authorized Person/Installer, who shall also carry out a complete examination to ensure the system complies of all relevant sections of this standard and any other statutory requirements as specified by the Central Government.

6.2.1.1 *Initial inspection and installation certificate*

The system shall be leak tested as specified in **6.2.2**. The installation shall be inspected for compliance with this standard and all components shall be checked for operational performance. In the case of bi-fuel fuel installations, the ability for the vehicle to operate on the optional fuel shall also be tested.

When the system conforms to this standard, an installation certificate, as per Annex C of this standard, signed by authorized person/installer shall be issued to the owner of the vehicle.

6.2.1.2 *Periodic ispection/preventive maintenance*

6.2.1.2.1 The cylinder, piping and all components of the system shall be examined by an installer for corrosion, deterioration and for any modification affecting compliance with this standard, at least once in a year or incase of malfunction or accident. The inspection shall include leak testing as per **6.2.2**.

NOTE — Every CNG bus manufacturer/installer shall incorporate periodic inspection schedules in the operation and owner's manuals.

6.2.1.2.2 When the system has been inspected and any defects remedied and the system conforms to this standard to the satisfaction of the installer, a checklist as per Annex D (in case of CNG buses) and as per Annex E (in case of CNG vehicles other than CNG buses) shall be issued to the owner of the vehicle.

6.2.2 *Leak Test*

6.2.2.1 *Initial test*

At the time of commissioning, the complete pressure system shall be subjected to a pressure test of 20 ± 1 MPa by using CNG or a gas inert to CNG such as nitrogen.

6.2.2.2 *Procedure*

a) With boot or cylinder compartment open and vapour sealing removed from cylinder valve area and cylinder valve closed, slowly pressurize the system.
b) Leak test lines, fittings and components using a non-corrosive foaming agent and when leak free.
c) Open cylinder valve, pressurize cylinder and check for leaks at valve and cylinder neck.
d) When the system is passed leak free seal venting area.

WARNING — The system must not be subjected to a shock loading as insecure fittings could blow out with dangerous results, and burst discs could rupture.

6.2.2.3 *Gas tightness of compartments and sub-compartments*

6.2.2.3.1 The compartment and sub-compartment shall be tested at the time of commissioning and subsequently at each periodic inspection to ensure that it is gas tight to the vehicle interior by blowing tracer gas into the compartment or sub-compartment and testing the surrounding atmosphere for gas leakage with a gas detector. Passages between the compartment and outside air, for example: ventilation provisions, or an access hatch or door in the case of a permanently in-built compartment, should be sealed during testing. Any leakage should be rectified, and testing repeated.

6.2.2.3.2 Should the compartment or sub-compartment fail the above tests, corrective action shall be taken and the tests repeated until they comply with the test requirements.

NOTE — It may be permissible to check such a compartment or sub-compartment before installation of the fuel system, provided that nothing in the subsequent installation procedure will negate the validity of the test.

6.2.2.4 Where CNG is used for testing, the following precautions shall be observed:

a) Testing shall be carried out under adequately vented conditions.
b) Testing shall be carried out at least 5 m from any open flame or other source of ignition.

6.2.2.5 The operation of the equipment and controls shall also be tested with CNG under normal working conditions to prove satisfactory performance of the entire system and a further leak test shall be carried out using a non-corrosive foaming agent.

6.2.2.6 BCF fire extinguisher and dry powder fire extinguisher conforming to IS 2171 and each of 5 kg shall be kept ready within a safe distance. If ignition occurs the service valve should be closed and the extinguisher(s) used to quell any fire, which may continue.

6.3 Garaging and Repair (for Installer)

6.3.1 *Garaging and Repairing of CNG Fuelled Vehicles*

Vehicles fueled with CNG may be stored or serviced and repaired inside garages provided that the following conditions are observed:

a) There shall be no leaks in the fuel system,
b) Such vehicles shall not be parked within 3 m of any sources of ignition,
c) CNG fueled vehicles being repaired in garages, unless the fuel is required for engine operation, shall have the cylinder shut-off valve closed and the CNG fuel in the service line exhausted by running the engine or depressurizing the line in a well-ventilated area, and
d) Vehicles undergoing repairs involving welding or the application of heat, to any part within 1 m of the cylinder, shall have the cylinder removed or shielded from the source of heat.

6.3.2 *Repair Operation*

6.3.2.1 Repair operation involving heat shall be carried out with due regard to fire safety.

6.3.2.2 Damaged fuel lines shall not be repaired; in all cases they shall be replaced.

6.3.2.3 Welding, brazing and the application of heat shall not be carried out on any part of the cylinder subsequent to manufacture.

6.3.2.4 When a vehicle is involved in an accident causing damage to part of all of the CNG fuel system or where any part of the system necessitates removal to allow for the repair of the vehicle the system shall, after re-assembly or repair, be tested in accordance with **6.2** and a checklist as per Annex D (in case of CNG buses) and Annex E (for vehicles other than CNG buses) be issued. If applicable the requirements of **6.3.3.2** shall also be met.

6.3.3 *Scrapping*

6.3.3.1 A vehicle, which is about to be scrapped, shall have its cylinder removed prior to disposal.

6.3.3.2 Where the cylinder has been subjected to impact or fire damage the cylinder shall be inspected and re-tested by the owner of the vehicle as per *Gas Cylinder Rules*, 2004 as amended from time-to-time.

NOTE — There will always be combustible gas in the cylinder until it has been cleared of all traces of flammable vapour or gas.

7 STATUTORY AUTHORITY APPROVAL

The type of component in question and its use determine the Statutory Authority Approval in respect of CNG fuel system components. The statutory areas of responsibility are:

Government Agency	*Statutory Powers*	*Scope of Application*
Ministry of Shipping, Road Transport and Highways, Government of India	*Motor Vehicle Act*, 1988 *Central Motor Vehicle Rules*, 1989	All CNG kit components [excluding CNG cylinder and its valve(s)] and systems used for the purpose of propelling a motor vehicle on road.
Petroleum and Explosive Safety Organization (PESO), Government of India	*Gas Cylinder Rules*, 2004	CNG cylinder with valves and their accessories.

8 MARKING

The components shall be permanently marked with the manufacturer's name, trade-mark or symbol as per their relevant standards.

ANNEX A

[*Clause* 4.9.2.3.1(h)]

FREEZING CONDITIONS AND CORROSIVE CONDITIONS

A-1 Where regulator heat is drawn from the engine cooling water, care should be taken to ensure that the water does not freeze in the regulator during cold weather. Expansion of the water on freezing can cause serious damage to the pressure regulator assembly.

A-2 Most CNG regulators are made from non-ferrous alloys, which can suffer pinhole corrosion under certain conditions. If this is allowed to take place CNG can be admitted to the cooling water system where it will pressurize the radiator and cause a potential hazard. It is important, therefore, to have an effective anticorrosion additive present in the cooling water.

A-3 It is important to ensure that the coolant additive and the dilutant ratio comply fully with the engine manufacturer's requirements.

ANNEX B

(*Clause* 4.9.2.4.1)

BACKFIRE — DEFLECTOR TESTS

B-1 A backfire deflector under backfire conditions shall contain a visible flame front within its confines and shall not be displaced, physically damaged or distorted, or show evidence of burning or smoldering of internal parts. If the deflector is of the oil-bath type, it shall be free of any overflow or discharge permitting accumulation of oil on electrical, hot-engine or exhaust system parts.

B-2 A complete industrial truck/vehicle is to be used for this test. Tests are not required on backfire deflectors employed diesel engines.

B-3 The backfire deflector (air cleaner, oil-bath or dry element type) and connecting hose are to be removed from the engine. The spark timing is to be advanced (approximately 8°) and the spark plug leads are to be interchanged to obtain sharp backfires under the following conditions. The engine is to be alternately raced and idled and the ignition switch is to be operated to alternately energize and de-energize the ignition system. During the test, the intensity of the backfire and the issuance and extent of the accompanying flame are to be noted.

B-4 The backfire deflector (air cleaner) is then to be installed on the truck in the intended location. An oil-bath type deflector (air cleaner) is to be filled to the marked "full level-line" of the bowl. Paper is to be placed beneath the intake orifices of an oil-bath type and over adjacent surfaces of parts likely to be affected by accumulations of oil.

B-5 The engine is then to be operated in the several manners determined in the preliminary test to provide for the most severe backfire conditions. At least ten and not more than twenty backfires are to be produced.

B-6 Observations for containment of flame are to be made under semi-darkened conditions by at least two observers. No visible flame is to be in evidence at any time during the tests. In the tests of an oil-bath type, paper is not to show evidence of oil deposits in the form of droplets.

B-7 A dry-type filter element is to be tested in the above manner, then removed and then subjected to five consecutive washing and drying cycles. Washing is to consist of immersion in plain water together with sufficient agitation to remove bulk material adhering to the outside surface. The test element is then to be remounted as intended in operation, and the backfire test is to be repeated.

B-8 The side of the filter media normally exposed to backfire is then to be subjected to a flame source of sufficient intensity to cause the media to burn or glow. The flame source is then to be removed and an acceptable filter media is not to continue to burn or smolder.

ANNEX C

(*Clause* 6.1.9)

INSTALLATION CERTIFICATE FOR CONVERTED CNG VEHICLE

(To be filled in by installer)

A. Details of Installer Approval:	
1. Installation Certificate issued by	Name and address of installer
2. Approval of installer	Name of vehicle manufacturer/kit manufacturer/kit supplier, who has approved the installer
3. Type of vehicle converted	3-Wheeler/Car/LCV/HCV, etc
4. Approval of the CNG kit	
a) Name of the Test Agency	
b) Approval Certificate No. and Date	
B. Details of Converted Vehicles	
1. Regn. No. and year of manufacture	
2. Chassis and Engine No.	
3. Type of Operation	Bi-fuel/dedicated fuel
C. Details of CNG Kit	
1. Cylinders	
a) No. of Cylinder/s	
b) Type of Cylinder/s	
c) Cylinder No/s.	
d) Make	
e) Water Capacity (litres)	
f) Working Pressure (kg/cm^2)	
g) Approval reference of DOE	
h) Validity of DOE Certificate	
2. Cylinder Valves	
a) Make	
b) Valve No.	
c) Working Pressure (kg/cm^2)	
d) Approval reference of DOE	
3. Refilling Valve	
a) Make	
b) Type	
4. Fuel Line	
a) High pressure pipe dia (ID/OD)	
b) Low pressure pipe dia (ID/OD)	
5. Shut-Off Valve (Solenoid Valves)	
a) Make	
b) Type	
c) Operation Voltage	
6. Fuel Selection Switch	
a) Make	
b) Type	

7. Regulator
   a) Make
   b) Type
   c) Sl No.
8. Gas-Air Mixer
   a) Make
   b) Type

NOTE — This certificate shall be filled and provided to vehicle owner for all vehicles converted for CNG operation.

Signature & Seal of Installer

ANNEX D

(*Clause* 6.2.1.2.2)

CHECKLIST FOR THIRD PARTY CHECKING/INSPECTION OF BUILT UP CNG BUSES (NEW AND CONVERTED/RETROFITTED IN-USE) BEFORE REGISTRATION

D-1 DETAILS OF CNG BUS	
1. a) Name and address of chassis manufacturer (applicable for new and converted/retrofitted in-use) b) Name and address of retrofitter (applicable for converted/retrofitted in-use) c) Name and address of engine manufacturer (applicable for converted/retrofitted in-use)	
2. Name of type approval agency	
3. Details of type approval certificate	
4. Name and address of bus body builder	
5. Name and address of approved inspecting agency at R.T.O.	
6. Chassis and engine No.	
7. Year of manufacture	
D-2 DETAIL OF CNG SYSTEM	
D-2.1 Checking of Cylinders as per DOE/Vehicle Testing Agency Approvals	
1. Validity of DOE Certificate 2. Safety checks a) Check for corrosion on any CNG components/mountings of gas circuit b) Check whether cylinder is securely mounted within the vehicle and check tightness of nuts and bolts c) Check whether minimum 5 mm clearance is kept between cylinders and vehicle body structure d) Distance between cylinder valve and bus body extremities shall not be less than 200 mm unless valves are protected (as per the details provided by the kit/vehicle manufacturer/kit supplier and duly vetted and approved by test agencies) to minimize the possibility of damage due to collision, overturning/other accident.	

e) Check that the material of the padding/lining provided for inner side of cylinder mounting band (s) is made up of EPDM rubber (hardness Shore A 60 min) as approved by the test agency during type approval certification. NOTES 1 In case of doubt, Inspecting agencies will request the OE vehicle manufacturer/retrofitter to supply the sample of material for padding rubber which has been type approved by the testing agencies. 2 Rubber packing, if found damaged during inspection it should be replaced by the new material having revised specification.	
D-2.2 Cylinder Valves	
1. Check specific type and model approved by vehicle testing agency for the vehicle under inspection 2. Check for operation 3. Check for shield/protection 4. Check for physical damage to valves 5. Check for burst disc with fusible plug as approved by DOE 6. Leak test using non corrosive foaming agent (for example snoop of M/s Swagelok, collin etc) or methane leak detector	
D-2.3 Refilling Valve	
Safety checks: a) Check for dust cap/plug b) Check that engine should not start when dust cap/plug is removed or open c) Check for proper make and type of interlocking switch as approved by testing agencies. d) Check leakage for non-return valve using non corrosive foaming agent (that is snoop of M/s Swagelok, collin etc) or methane leak detector	
D-2.4 Fuel Line	
Safety checks: a) Check for corrosion, damage on CNG fuel line (In case of PVC sleeved fuel line, corrosion shall be inspected at the ends, wherever it is exposed. Also inspect for any damage to the sleeving. Sleeve should be firmly gripped to the CNG fuel line) b) Check whether fuel line is securely mounted c) Check for deformation of U and Pigtail bends provided in high pressure piping for flexibility as per approved layout d) Distance between fuel line and exhaust pipe/shield shall not be less than 75 mm and the fuel line should also be properly clamped and routed so as not to touch the engine block e) Check whether effective protection is provided, as per approved layout, to prevent the possibility of damage due to loose objects from road. f) Check the distance between any two clips which shall not be more than 600 mm g) Leak test using non-corrosive foaming agent (that is snoop of M/s Swagelok, collin etc.) or methane leak detector	

D-2.5 Shut-Off Valve [Solenoid Valve(s)] Wherever Separately Provided	
Safety checks: a) Verify the following as per type approval specification 1) Make 2) Type (if applicable) 3) Identification No. b) Check whether shut off valve is securely mounted c) Check operation for "Close and Open" as required d) Leak test using non-corrosive foaming agent (that is snoop of M/s Swagelok, collin etc.) or methane leak detector	
D-2.6 Regulator	
Safety checks: a) Verify the following as per type approval specification: 1) Make 2) Type (if applicable) 3) Identification No. b) Check whether regulator is securely mounted c) Leak test using non-corrosive foaming agent (this is snoop of M/s Swagelok, collin etc.) or methane leak detector	
D-2.7 Gas-Air Mixer	
Safety checks: a) Verify the following as per type approval specification 1) Make 2) Type (if applicable) 3) Identification No. b) Check whether gas-air mixer is securely mounted c) Leak test using non-corrosive foaming agent (that is snoop of M/s Swagelok, collin etc) or methane leak detector	
D-2.8 Electrical Wiring (Safety Checks)	
D-2.8.1 *For OE & Converted/Retrofitted In-Use Vehicles* a) Check whether that current limiting device (fuse) is fitted as per manufacturer specifications and make b) Terminals are insulated to prevent shorting c) Wiring are taped and clipped with loom and mounted securely. d) Battery shall be securely mounted and battery terminal shall be locked properly by means of suitable nut and bolt with washers e) Check installation of battery cut-off switch as per chassis manufacturer's recommendations. Location of Battery cut-off switch should be within the reach of driver in seating posture in driving seat f) Check routing of high tension cable to avoid accidental earthing and to be placed away from any heat source — as per chassis manufacturer's recommendations/layout g) Check for proper make of high tension cable as per chassis manufacturer's recommendation as well as check for tight fitment of its terminal to the spark-plug **D-2.8.2** *For OE Vehicles* a) Check wiring harness layout under the floor and in the engine compartment to be in accordance with chassis manufacturer's layout/specifications/approval,	

b) Check wiring harness in cabin and passenger compartment to be as per chassis manufacturer's guidelines/approval, and

c) Cable harness has to be as per the recommendations of OE chassis/vehicle manufacturers.

D-2.8.3 *For Converted/Retrofitted In-Use Vehicles*

Check wiring harness layout under the floor/cabin and passenger compartment for proper sleeving and routing in order to avoid accidental sparking.

D-2.9 Service Shut-Off Valve

Safety checks:

a) Make and type,

b) Check operation,

c) Check whether service shut-off valve is securely mounted, and

d) Leak test using non-corrosive foaming agent (that is snoop of M/s Swagelok, collin etc) or methane leak detector.

D-2.10 CNG Filter

a) Check whether CNG filter is securely mounted,

b) Leak test using non-corrosive foaming agent (that is snoop of M/s Swagelok, collin etc.) or methane leak detector.

D-2.11 CNG Pressure Gauge

a) Make and type

b) Check whether CNG pressure indicator is securely mounted

c) Leak test using non-corrosive foaming agent (that is snoop of M/s Swagelok, collin etc) or methane leak detector

D-2.12 Compliance Plate

Installation Check

Check for Following	Details for No. of Cylinders					
	1	2	3	4	……	…
a) Cylinder identification No.						
b) Date of last testing and the name of certifying agency						
c) Water capacity (ltr)						
d) Next due date of testing						
e) Date of Installation						
f) Water capacity (ltr) of total installation						
g) Vehicle registration/identification No. (to be furnished after registration)						
h) Seal/Identification of the checking/inspection agency (who carries out the 3rd party inspection)						
i) Check whether compliance plate is installed near filling connection and be clearly visible to the filling agency						

D-2.13 Identification Label in Front and Rear

Located on left side of the front and rear safety glass and shall ensure visibility from front and rear sides

D-2.14 Catalytic Convertor (Wherever it is Part of Kit)	
Verify make and type of the catalytic converter as per the vehicle manufacturer's specification and/as given in the type approval certificate as the case may be.	
D-2.15 Low Pressure Hose	
a) Verify make and type of the low pressure hose as per the type approval specification. b) Check for kinks, damage or abrasion to the cover. NOTE — In case of doubt, Inspecting Agencies will request the OE vehicle manufacturer/retrofitter to supply the sample of material for low pressure hose which has been type approved by the testing agencies.	
D-2.16 Additional Checks	

Following additional points are to be complied at the time of registration/before endorsement by the competent authority (after conversion) of CNG vehicle for enhancement of safety of vehicle:

a) Fire retardant material conforming to IS 15721 for seat/upholstery/roof and side lining and IS 2465 for wiring cables shall be used. The OE/Vehicle manufacturer/retrofitter shall submit declaration with respect to design; manufacturing processes and material conforming to the use of fire retardant materials (*see* Notes 1 and 2).

b) One number each of dry powder type fire extinguishers (2 kg) shall be provided in driver's and passenger's compartment.

c) For servicing of CNG vehicle proper instructions, detail operational and service manual with Dos and Don'ts shall be provided by chassis manufacturer and body builder/retrofitter. Vehicle/chassis manufacturer/retrofitter should devise training module and impart training to drivers and technicians for safe operation of CNG system.

d) Check for first-aid kit as per CMVR.

e) Distance between the exhaust line, muffler and fuel line shall be a minimum of 75 mm. If not a radiant heat shield of 2mm thickness shall be welded in between.

f) Safety plates/shield below the pipe joints shall be welded and proper inspection windows shall be provided near the cylinder joints.

g) Minimum two copies of safety instructions shall be displayed in passenger's compartment.

h) Check for proper venting provided by louvers/holes/mesh on the side skirt so that in case of any leakage the entrapped gas under the floor escapes to the atmosphere.

j) The bus body builder/retrofitter to provide at least two (total minimum area of 550 mm^2) vent pipes connecting the under floor of the bus to the rooftop for CNG gas to vent out in case of leakage. The vent pipes to be located close to the cylinder valves cluster as per recommendations of chassis manufacturer. Construction should be such that leakage into passenger compartment is avoided.

k) Any other safety recommendations provided or advised by the chassis manufacturers to be complied with.

NOTES

1 For OE fully built vehicles, type approval is subjected to meeting the requirements as mentioned above. In case of type approval of drive-away chassis, declaration from chassis manufacturer for above tests shall be verified by inspection agency.

2 In case of doubt, Inspecting Agencies will request the OE vehicle manufacturer/retrofitter to supply the sample of material for cables/seat/upholstery/roof and side lining which has been type approved by the testing agencies.

3 The instructions issued by OE manufacturer/retrofitter for third party evaluation, in their instruction manual, shall contain all the necessary details on the methodology and the procedure for carrying out these checks.

Signature & Seal with date

ANNEX E

(*Clause* 6.2.1.2.2)

CHECKLIST FOR THIRD PARTY CHECKING/INSPECTION OF CNG VEHICLES (OTHER THAN CNG BUSES) THAT IS TWO, THREE AND FOUR WHEELER, BEFORE REGISTRATION (NEW AND CONVERTED/RETROFITTED IN-USE)

E-1 DETAILS OF CNG VEHICLE	
E-1.1 Manufacturer's Details a) Name and address of OE Vehicle manufacturer, b) Name and address of the Drive Away Chassis Manufacturer (applicable for new and converted/retrofitted in-use), c) Name of the Retrofitter holding the type approval certificate, d) Name of the authorized kit installer duly authorized by the original retrofitter, and e) Name and address of Body builder (if applicable).	
E-1.2 Name of Type Approval Agency	
E-1.3 Reference Number of Type Approval Certificate and Validity Gasoline Vehicles (Converted/retrofitted in-use): a) CC of base model tested b) Flexibility available for conversion ± 25% of the base model c) Period of validity, from — to — Diesel Vehicles (Converted/retrofitted in-use): a) Type and make of model b) Year of manufacture c) Period of validity, from — to — In the case of OE, a) Validity will be for the base model and its variants given in the type approval certificate b) Period from — to — (as given in the type approval certificate)	
E-1.4 Name and Address of Approved Inspecting Agency at R.T.O.	
E-1.5 a) Vehicle Registration No. (if applicable) b) Vehicle type and model	
E-1.6 Chassis and Engine No. ■ Original as per RCTC or ■ New in case of replacement of engine	
E-1.7 Year of Manufacture a) Chassis in case of drive-away chassis b) Fully built up vehicle c) Month & year of conversion	

E-2 DETAIL OF CNG SYSTEM	
E-2.1 Checking of Cylinders as per DOE/Vehicle Testing Agency Approvals	
Validity of DOE Certificate	
Safety checks: a) Check for corrosion on any CNG components/mountings of gas circuit. b) Check whether cylinder is securely mounted within the vehicle and check tightness of nuts and bolts. c) Check whether minimum 5 mm clearance is kept between cylinder and vehicle body structure and also in between the cylinders, if applicable. d) Distance between cylinder valve and vehicle body extremities shall not be less 200 mm unless valves are protected (as per the details provided by the kit/vehicle manufacturer/kit supplier and duly vetted and approved by test agencies) to minimize the possibility of damage due to collision, overturning/other accident. e) Check for reinforcement if cylinder is mounted on floor of the vehicle (minimum dimension of reinforcement thickness and surface area shall not be less than 2.5 mm and 3 600 mm^2 respectively). The reinforcement shall be provided on the top and bottom of the floor. f) Check that the material of the padding/lining provided for inner side of cylinder mounting band(s) is made up of EPDM rubber (hardness Shore A 60 min) as approved by the test agency during type approval certification.	
NOTES 1 In case of doubt, Inspecting Agencies will request the OE vehicle manufacturer/retrofitter to supply the sample of material for padding rubber which has been type approved by the testing agencies. 2 Rubber packing if found damaged during inspection it should be replaced by the new material having revised specification	
E-2.2 Cylinder Valves a) Check specific type and model approved by vehicle testing agency for the vehicle under inspection b) Check for operation c) Check for physical damage/distortion to valves d) Check for shield/protection e) Check for burst disc with fusible plug as approved by DOE f) Check for the vent pipe outlet routing away from exhaust in case of cylinder fitting in the enclosed compartment. g) Leak test using non-corrosive foaming agent (that is snoop of M/s Swagelok, collin etc) or methane leak detector	
E-2.3 Refilling Valve Safety checks: a) Check for dust cap/plug b) Check that engine should not start when dust cap/plug is removed or open • Check for proper make and type of interlocking switch as approved by testing agencies. c) Check leakage for non-return valve using non-corrosive foaming agent (that is snoop of M/s Swagelok, collin etc) or methane leak detector	

E-2.4 Fuel Line Safety checks: a) Check for corrosion, damage of CNG fuel line (In case of PVC sleeved fuel line, corrosion shall be inspected at the ends, wherever it is exposed. Also inspect for any damage to the sleeving. Sleeve should be firmly gripped to the CNG fuel line) b) Check whether fuel line is securely mounted c) Check for U and Pigtail bends provided in high pressure piping for flexibility as per approved layout d) Check whether effective protection is provided, as per approved layout, to prevent the possibility of damage due to loose objects from road. e) Distance between fuel line and exhaust pipe/shield shall not be less than 75 mm and the fuel line should also be properly clamped and routed so as not to touch the engine block f) Check the distance between any two clips which shall not be more than 600 mm (500 mm and 300 mm incase of 3/2 wheeler respectively). g) Leak test using non-corrosive foaming agent (that is snoop of M/s Swagelok, collin etc.) or methane leak detector	
E-2.5 Shut-off Valve [Solenoid Valve(s) Wherever Separately Provided]	
Safety checks: a) Verify the following as per type approval specification: 1) Make 2) Type (if applicable) 3) Identification No. b) Check whether shut-off valve is securely mounted c) Check operation for "Close & Open" as required d) Leak test using non-corrosive foaming agent (that is snoop of M/s Swagelok, collin etc.) or methane leak detector	
E-2.6 Regulator Safety checks: a) Verify the following as per type approval specification: 1) Make 2) Type (if applicable) 3) Identification No. b) Check whether regulator is securely mounted c) Leak test using non-corrosive foaming agent (that is snoop of M/s Swagelok, collin etc.) or methane leak detector	
E-2.7 Gas-Air Mixer Safety checks: a) Verify the following as per type approval specification: 1) Make 2) Type (if applicable) 3) Identification No. b) Check whether gas-air mixer is securely mounted c) Leak test using non-corrosive foaming agent (that is snoop of M/s Swagelok, collin etc.) or methane leak detector	

E-2.8 Electrical Wiring Safety checks: FOR OE AND CONVERTED/RETROFITTED IN-USE VEHICLES a) Check whether that current limiting device (fuse) is fitted as per manufacturer specifications and make b) Terminals are insulated to prevent shorting c) Wiring are taped and clipped with loom and mounted securely d) Battery shall be securely mounted and battery terminal shall be locked properly by means of suitable nut and bolt with washers e) Check installation of battery cut-off switch as per vehicle/chassis manufacturer's recommendations (if applicable). Location of battery cut-off switch should be within the reach of driver in seating posture in driving seat f) Check routing of high tension cable to avoid accidental earthing and to be placed away from any heat source — as per vehicle/chassis manufacturer's recommendations/layout or as approved by Test Agency g) Check for proper make of high tension cable connected to spark plug as per vehicle/chassis manufacturer's recommendation. Check for tight fitment of its terminal to the spark-plug	
FOR OE VEHICLES a) Check wiring harness layout under the floor and in the engine compartment to be in accordance with vehicle/chassis manufacturer's layout/specifications/ approval b) Check wiring harness in cabin and passenger compartment to be as per vehicle/chassis manufacturer's guidelines/approval c) Cable harness has to be as per the recommendations of OE chassis/vehicle manufacturers FOR CONVERTED/RETROFITTED IN-USE VEHICLES Check wiring harness layout under the floor/cabin and passenger compartment for proper sleeving and routing in order to avoid accidental sparking.	
E-2.9 Service Shut-Off Valve Safety checks: a) Make and type b) Check operation c) Check whether service shut-off valve is securely mounted d) Leak test using non-corrosive foaming agent (that is snoop of M/s Swagelok, collin etc) or methane leak detector	
E-2.10 CNG Filter (Wherever Separately Provided) a) Check whether CNG filter is securely mounted b) Leak test using non-corrosive foaming agent (that is snoop of M/s Swagelok, collin etc.) or methane leak detector	
E-2.11 CNG Pressure Gauge a) Make and type b) Check whether CNG pressure indicator is securely mounted c) Leak test using non-corrosive foaming agent (that is snoop of M/s Swagelok, collin etc) or methane leak detector	

E-2.12 Compliance Plate

Installation Check

Check for FolloPwing	Details for No. of Cylinders					
	1	2	3	4	......	......
a) Cylinder identification No.						
b) Date of last testing and the name of certifying agency						
c) Water capacity (ltr)						
d) Next due date of testing						
e) Water capacity (ltr) of total installation						
f) Vehicle registration/identification No. (to be furnished after registration)						
g) Seal/Identification of the checking/inspection agency (who carries out the 3rd party inspection)						
h) Check whether compliance plate is installed near filling connection & be clearly visible to the filling agency						

E-2.13 Identification Label in Front and Rear Located on left side of the front and rear safety glass and shall ensure visibility from front and rear sides	
E-2.14 Compartment/Sub-Compartment/Gas Tight Housing (for Internally Mounted Cylinder/s) a) Check whether Compartment/Sub-compartment/Gas tight housing is in good condition that is shall not show any crack/damage. b) Check whether it is firmly clamped to the conduit/vent hose/ducting	
E-2.15 Conduits/Ducting/Vent Hose (for Internally Mounted Cylinder/s) Check whether Conduits/ducting is in good condition that is shall not show any crack/damage	
E-2.16 Petrol Shut-off Valve (Solenoid) (if Applicable that is Gasoline Injection Vehicle does not Require such Solenoid Valve) a) Check operation b) Check whether Petrol shut-off valve is securely mounted c) Leak test (visual inspection) d) Verify the make and type as per the Type Approval specification	
E-2.17 Fuel Selection Switch (for Bi-fuel Mode) • Check operation	
E-2.18 Catalytic Converter (Wherever it is Part of Kit) Verify make and type of the catalytic converter as per the vehicle manufacturer's specification and/as given in the type approval certificate as the case may be.	
E-2.19 Low Pressure Hose a) Verify make and type of the low pressure hose as per the Type Approval specification b) Check for kinks, damage or abrasion to the cover NOTE — In case of doubt, Inspecting Agencies will request the OE vehicle manufacturer/ retrofitter to supply the sample of material for low pressure hose which has been type approved by the testing agencies.	

E-2.20 Following additional points are to be complied at the time of registration/before endorsement by the competent authority (after conversion) of CNG vehicle for enhancement of safety of vehicle.

a) Fire retardant material conforming to IS 15721 for seat/upholstery/roof and side lining and IS 2465 for wiring cables shall be used. The OE/Vehicle manufacturer/retrofitter shall submit declaration with respect to design, manufacturing processes and material conforming the use of fire retardant materials (*see* Notes 1 and 2).

b) One number each of dry powder type/CO_2 type fire extinguishers (1 kg), for 4 wheelers (car, LCV, etc) only, shall be provided in driver's and passenger's compartment. In case of 3 wheeler where the driver and passengers compartments are not isolated one number of dry powder type/CO_2 type fire extinguisher (1 kg) shall be provided.

c) For servicing of CNG vehicle proper instructions, detailed operational and service manual with Dos and Donts shall be provided by kit/vehicle manufacturers. Vehicle/kit manufacturer/kit supplier should devise training module and impart training to drivers and technicians for safe operation of CNG system.

d) Check for First-Aid kit as per CMVR.

e) Safety plates/shield below the pipe joints shall be welded and proper inspection windows shall be provided near the cylinder joints.

f) Minimum two copies of safety instructions shall be displayed in passenger's compartment.

g) Check the following for the vehicles other than M1 category; fitted with multi CNG cylinders not incorporating the independent venting system.

    1) Check for proper venting provided by louvers/holes/mesh on the side skirt so that in case of any leakage the entrapped gas under the floor escapes to the atmosphere.

    2) The Vehicle/kit manufacturer/kit supplier to provide at least two (total minimum area of 550 sq. mm) vent pipes connecting the under floor of the vehicle to the rooftop for CNG gas to vent out in case of leakage. The vent pipes to be located close to the cylinder valves cluster as per recommendations of chassis manufacturer. Construction should be such that leakage into passenger compartment is avoided.

h) Any other safety recommendations provided or advised by the Vehicle/kit manufacturer/kit supplier to be complied with.

NOTES

1 For OE fully built vehicles, type approval is subjected to meeting the requirements as mentioned above. In case of type approval of drive-away chassis; declaration from chassis manufacturer for above tests shall be verified by inspection agency.

2 In case of doubt, Inspecting Agencies will request the OE vehicle manufacturer/retrofitter to supply the sample of material for cables/seat/upholstery/roof and side lining which has been type approved by the testing agencies.

The instructions issued by OE manufacturer/retrofitter for third party evaluation, in their instruction manual, shall contain all the necessary details on the methodology and the procedure for carrying out these checks.

Signature & Seal with date.

ANNEX F

(Foreword)

COMMITTEE COMPOSITION

Automotive Vehicles Running on Non-conventional Energy Sources Sectional Committee, TED 26

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Automotive Research Association of India, Pune	Shri M. K. Choudhari Shri A. B. Komawar *(Alternate)*
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